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MANUFACTURING "AMERICAN" STEEL PULLEYS*

TOOLS AND METHODS EMPLOYED IN PRODUCING BELT PULLEYS FROM SHEET STEEL

BY FRANKLIN D. JONES†

Fig. 1. "American" All-steel Split Pulley—Arms Integral with Hub

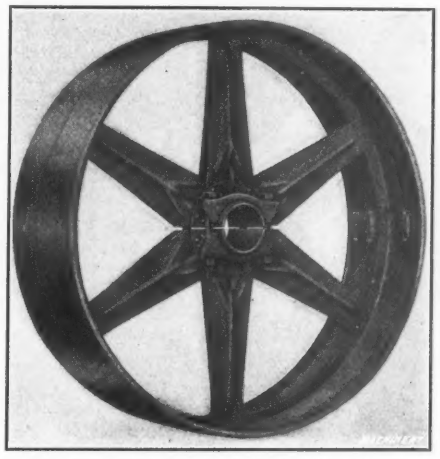

Fig. 2. "American" All-steel Split Pulley—Arms Riveted to Hub Flange

AT the plant of the American Pulley Co. at Philadelphia, the normal monthly output of pressed steel pulleys of various sizes is about 22,000. To manufacture this number of pulleys from sheet steel and secure a strong, accurate, well balanced product, requires highly specialized machines and constructional methods, many of which are interesting not only from a mechanical viewpoint, but as a study in efficient means of production. In this article the principal operations connected with the manufacture of the American pulley will be described. It should be mentioned that the order and nature of some of the operations for different sizes and designs of pulleys vary somewhat, as this company makes pulleys ranging from 3 to 72 inches in diameter; most of the operations which will be referred to, however, are common to all medium and large sizes and represent the most important processes.

Two types of "American" pulleys which have been widely used are shown in Figs. 1 and 2, these designs being for medium and large sizes, respectively. The hub of a half section of the type of pulley shown in Fig. 1 is integral with the arms, whereas the arms of the pulley illustrated in Fig. 2 are securely riveted to half an annular hub ring of angle section. In each case, the outer hub is riveted to an inner hub shell. Sizes varying from 44 to 72 inches, inclusive, have eight arms instead of six and the arms are bifurcated or forked where they are riveted to the hub ring. The forked ends which overlap are also riveted together, thus forming a rigid pulley especially adapted for heavy duty. The rim sections of all the pulleys are joined at the center by flanges, to which the arms are riveted, and the rims are beaded around the outside edges to stiffen them and make a safe rounded edge.

Forming Pulley Arms and Hub

The method of forming a half spider (including half the hub and three arms) for a pulley of the type shown in Fig. 1 is illustrated in Fig. 3. First, the flat steel stock is sheared to length and is then slit, as at *A*, in a die to form the three arms. The three arms are then corrugated, as at *B*, to stiffen them, in a hydraulic press equipped with suitable dies. (This operation for some pulleys is done later.) The flat, corrugated plate is next flanged in a V-shaped die, as at *C*, which is the first step in the formation of the hub, the latter being shaped in three operations. After the plate is flanged, the three arms are spread apart and the hub roughly formed as at *D*; then this roughly formed part is placed in another die where the hub is made round and the arms are spread and convexed to the proper degree, as at *E*. The die for the spreading operations *D* is shown in Fig. 4. This die is so arranged that the central arm of the slit plate is held by block *A* while the other two arms are being spread by the action of

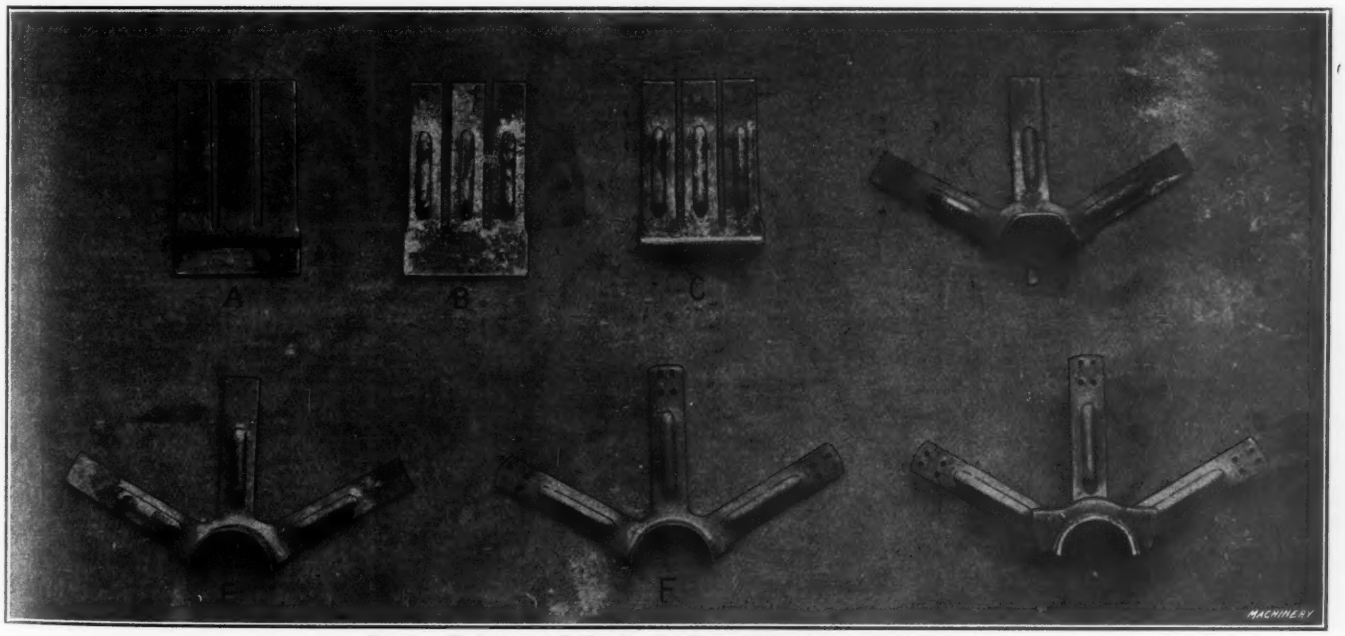

Fig. 3. Evolution of Spider for One Type of "American" Split Pulley

* For other articles on the manufacture of steel pulleys see "Making the Philips Pressed Steel Pulley in the November, 1913, number of MACHINERY.

† Associate Editor of MACHINERY.

a cylindrical shaped punch *B* which compresses the straight flange and roughly forms the hub.

After the hub has been formed and the arms are spread to the proper angle, the outer ends of the arms are pierced for the rim flange rivets, as at *F*, Fig. 3. The dies used for piercing these holes are shown in Fig. 5. The spider is clamped against locating plug *A* by lever *B* which operates a clamping slide, and the arms are located in relation to the punches by stop *C*. The extreme ends of the arms are next rounded in another die to approximately the curvature of the rim and are beveled on one side to avoid interference with the fillet of the rim flange. This beveling is necessary, for the ends of the arms which are milled to a uniform radius, as described later, must come in contact with the flange to insure an accurate pulley. Each arm is located for beveling by the pierced rivet holes which engage pins on the die. Holes are next drilled in the hub for the rivets which hold

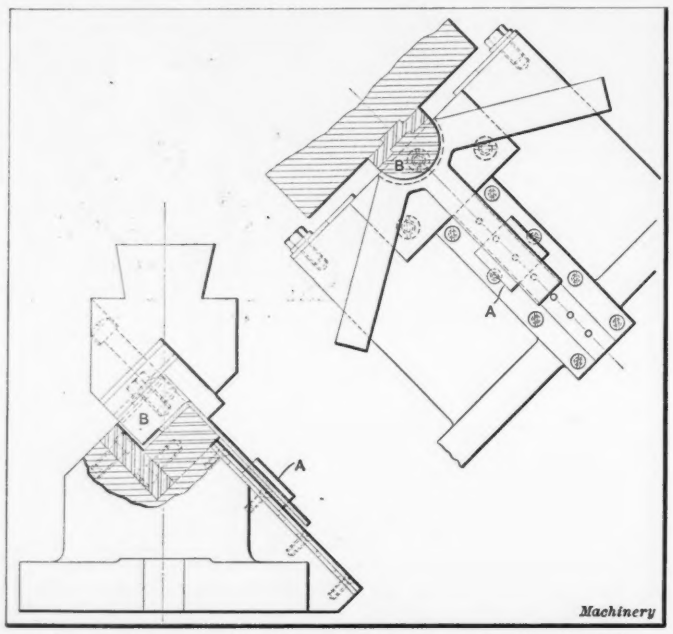

Fig. 4. Die for spreading Arms of Spider and roughly forming Hub

the inner shell. This drilling is done on the special multiple drilling machine shown in Fig. 6, the spindles of which are fed inward simultaneously, by the action of levers *B* operated by a cam at the rear. The work is held by three magnetized locating plugs *C*, which engage the arms at the rear. These plugs hold the work securely enough for drilling, but it

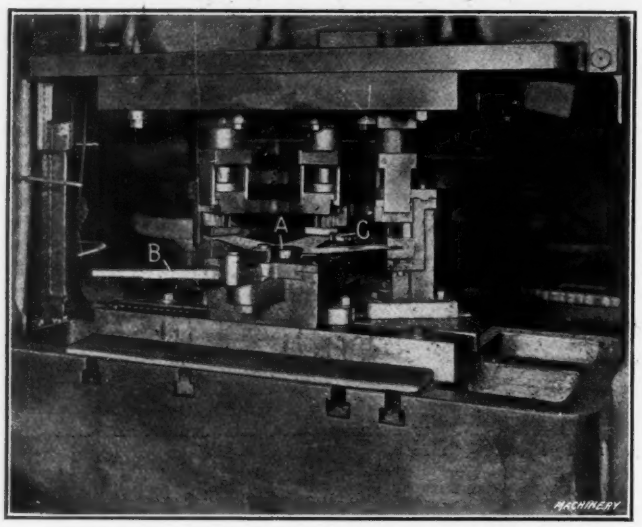

Fig. 5. Press and Dies for piercing Rivet Holes in Spider Arms

can be removed without demagnetizing the plugs. The location of the holes in the hub, relative to the arms, is controlled by pin *A* which engages a hole in the central arm, as shown.

The hub clamp shown attached to the hub at *G*, Fig. 3, is also formed of flat steel stock. This clamp, which is for the bolts that tighten the pulley hub on the shaft, is first blanked and then bent to a U-shape in a simple form of die; finally, the clamp is rounded to fit the hub and finished in the die illustrated in Fig. 7. This die has a rounded seat which conforms to the curvature required for the clamp, and a curved punch *A*. As the punch descends, the wedge-shaped plates *B* and B_1 at the sides engage plates *C* and C_1 which are forced inward, thus preventing the work from spreading or buckling while the forming operation takes place. As the punch

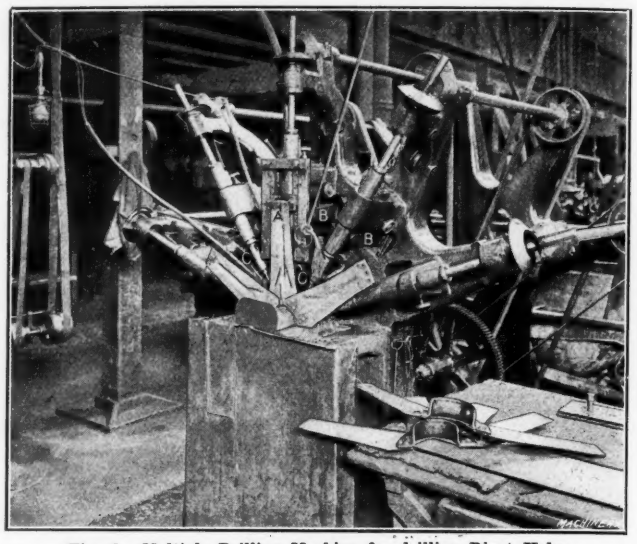

Fig. 6. Multiple Drilling Machine for drilling Rivet Holes in Hub of Spider

ascends, these plates loosen so that the work is easily ejected.

The assembling of the hub, hub clamp, and hub shell, to form the part shown at *G*, Fig. 3, is a riveting operation, hydraulic machines being used. The final operation on the pulley arms is shown in Fig. 8. Two half-sections or spiders are bolted around an accurately made bushing *A* which is not a part of the pulley but is a tool that represents the maximum shaft for which that particular pulley is adapted; this bushing is left in place until the pulley is completely assembled, riveted and tested. For the operation illustrated in Fig. 8,

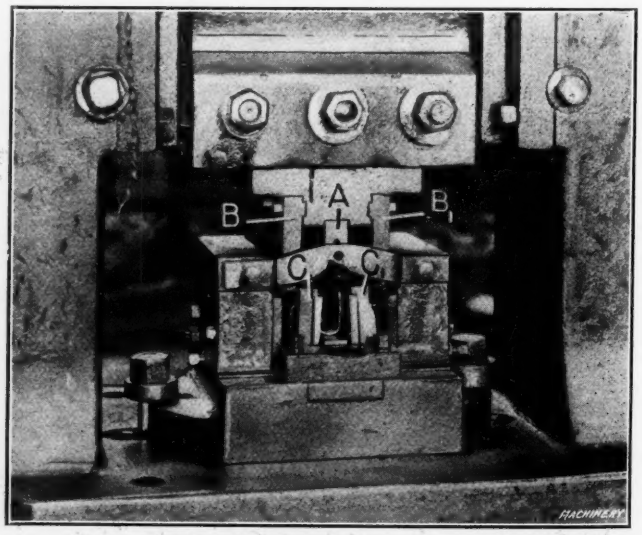

Fig. 7. Die for Final Forming Operation on Hub Clamp

which is that of milling the ends of the arms, this bushing is placed over a close-fitting plug and the arms are milled to a uniform radius by cutter *B*, the work being fed by simply turning it by hand. These milled surfaces insure a true pulley, as the rim sections are forced against them and are riveted in this position. Thus it will be seen that the accuracy of a pulley formed of sheet steel depends upon the design as well as upon the way in which it is manufactured.

Forming the Pulley Rim

The complete rim is composed of four sections, there being two sections in each half, joined by flanges at the center, as previously mentioned. These sections are first sheared approximately to length and then trimmed to an exact length in a die. At the same time, the corners are beveled slightly

so that the edges of the bead and flange will be radial after they have been formed, and the rim is made circular. These flat pieces are next passed through the rolls shown in Fig. 9, where they are roughly formed. The bead at the edge is partially turned over, as at *A*, and the flange is bent nearly at right angles. The last pair of rolls *B* is equipped with a crinkling device which uniformly corrugates the flange as shown at *C*, so that when the flange is pressed at right angles the bending action will be uniformly distributed and buckling prevented.

One of the large hydraulic presses used for finishing the rim sections is shown in Fig. 10. The rims are given the required shape by dies, and two sections are pressed simultaneously. This press has two large vertical plungers, one

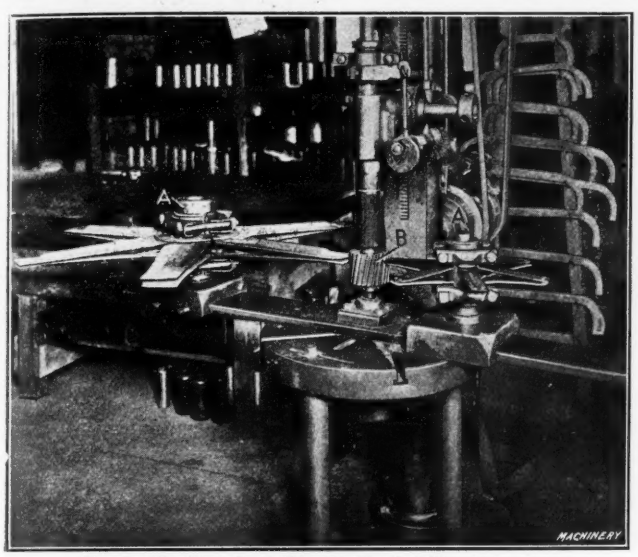

Fig. 8. Machine for milling Ends of Spider Arms to a Uniform Radius

being above the central inner die and one below it; in addition, there are four horizontal plungers located radially and 90 degrees apart. Two rough-rolled and crinkled rim sections are first inserted by two men standing one on each side of the press. The four radial plungers equipped with dies of the proper radius next move inward and press the rims against the central die. The upper vertical plunger then descends and forces the crinkled flange down flat and at right angles; when the flange is pressed and while the rims are held se-

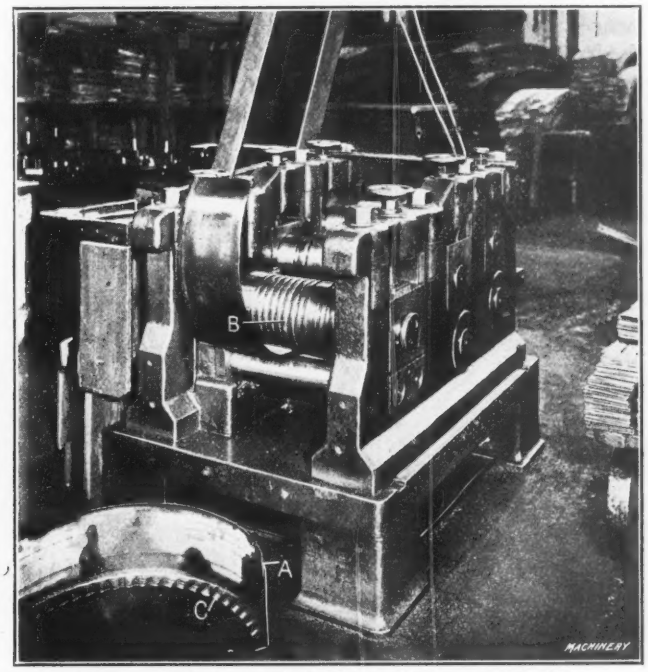

Fig. 9. Rolls for rough-forming Sections of Pulley Rim

curely, the lower plunger ascends and a curved beading die on it engages the edge of the rim (which it will be recalled was partially formed in the rolls) and rounds it, thus giving the rim a stiff outer edge. These operations are performed quite rapidly and the rims leave the press smoothly and accurately formed. The plungers are moved to and from the work by a pressure of about 150 pounds per square inch, but when the dies come into contact with the rims, the pressure is increased by an intensifier to 1000 pounds per square inch or more, in order to give the stock a permanent set. The rims for pulleys larger than 48 inches in diameter are not formed in a hydraulic press with dies, but are rolled to the required size.

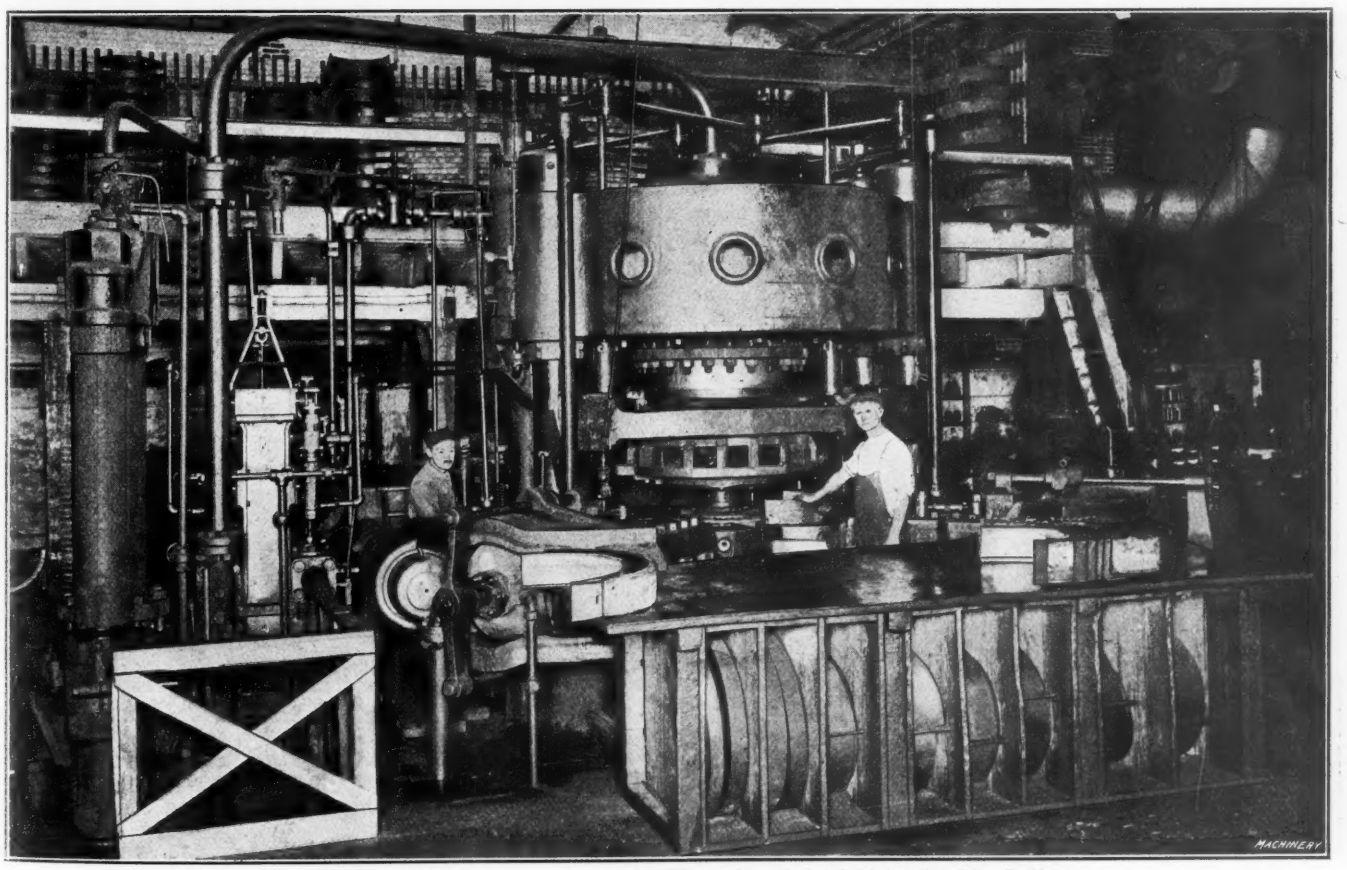

Fig. 10. Large Hydraulic Press equipped with Dies and used for finish-forming Rim Sections

The rim ends and flanges are next pierced for rivet holes, which completes the rim section. The dies for piercing the central flanges are shown in Fig. 11. It will be noted that the dies for each pair of holes in the rim are independently attached to a circular faceplate or platen *B* having radial T-slots. The die bases are tongued to fit these slots which are also engaged by the clamping bolts. Each die is accurately located radially by plugs *A* which pass through it and enter holes that extend parallel with the slots. With this simple construction, one die is made to cover a wide range of sizes. The punches are, of course, also adjustable on the upper platen. The dies used for piercing the arms (illustrated in Fig. 5) are also constructed on the same principle, so that they can be adjusted for pulleys of different diameters.

Assembling the Pulleys

The pulleys are assembled on stands as indicated in Fig. 12. A spider having arms milled to a uniform radius and a tool bushing bolted in the hub, as previously mentioned, is placed over the vertical stake of an assembling stand and loose rivets are inserted through the arms, rim flanges and bolt clamps. One half of the pulley rim is accurately aligned with the other half, by short dowel pins *A* which were previ-

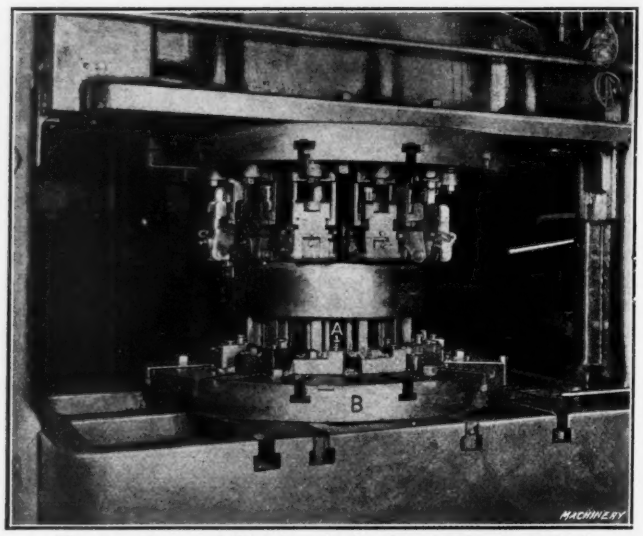

Fig. 11. Press and Dies for piercing Rivet Holes in Central Flange of Rim Section

ously inserted in the beaded edges. The assembled pulley is now taken to one of the hydraulic riveters (see Fig. 13) where the rivets are set. Before the riveting begins, the rim is firmly held against the ends of the milled arms by segments *A* which are forced in radially by an outer cam-ring *B*. This machine is used for setting rivets in the flange and arms. The rivets for the bolt clamps at the rim joint are set in the

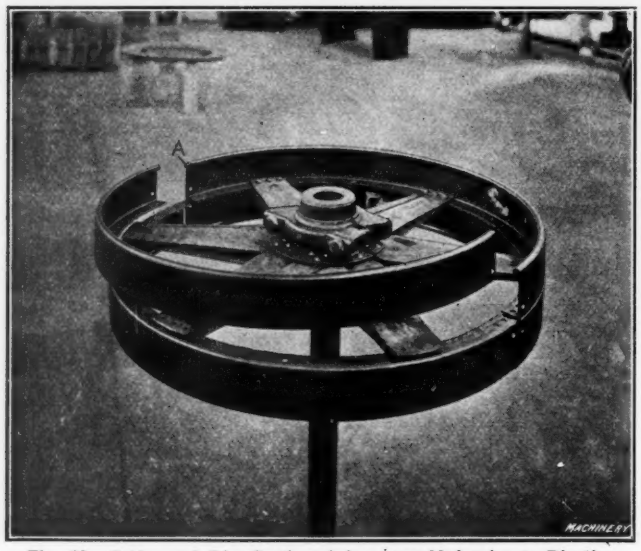

Fig. 12. Spider and Rim Sections being assembled prior to Riveting

special hydraulic riveter shown in Fig. 14. A heavy bar *A* passes through the pulley and provides a backing for the riveting dies *B* which receive the thrust of the lower plunger and dies *C*. When the rivets are set, the pulley is removed by simply pushing the bar back through bearing *D*.

Testing, Balancing and Inspecting

All finished pulleys are subjected to careful tests for accuracy and balance. The test for accuracy is made by the use

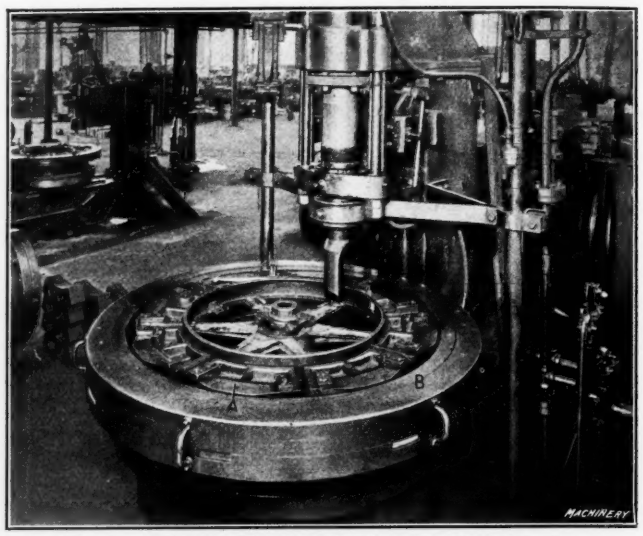

Fig. 13. Hydraulic Riveter equipped with Special Clamping Fixture for holding Rim against Milled Ends of Arms

of stands similar to that shown in Fig. 15. The spindle on which the pulley is mounted is revolved by a belt, as shown, and the stationary pointers *A* show whether the rims are circular and concentric or not. Screws *B* and B_1 at the sides show the accuracy in a lateral direction and are also used to force the pulley one way or the other, as may be required. Any slight local distortion of the rim is corrected by the

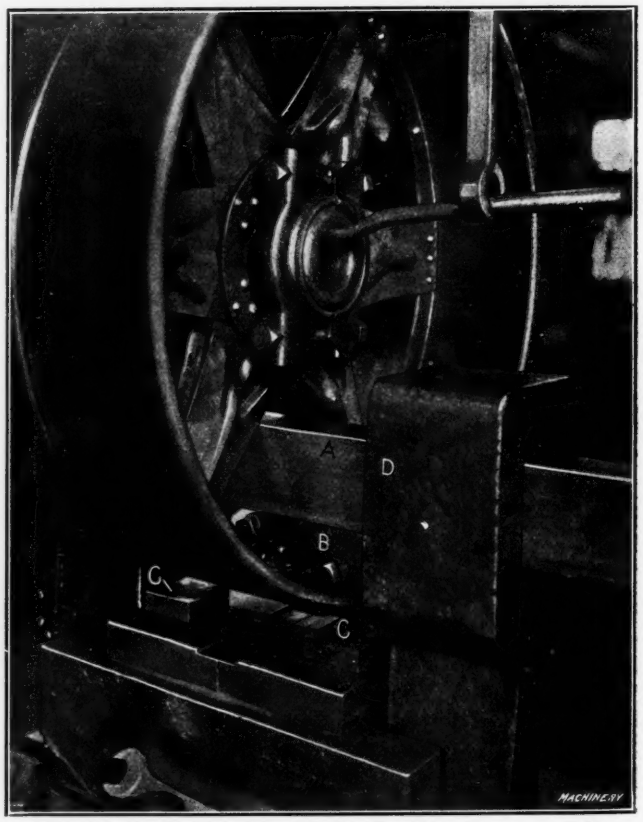

Fig. 14. Special Hydraulic Riveter for setting Rivets in Bolt Clamps at Rim Joint

special clamp tongs shown on the floor just in front of the stand. Most pulleys are very accurate, considering that the rim is not machined and that all the forming operations are effected by the use of dies.

After the accuracy test, the pulleys are tested for balance. In making this test, the pulley is mounted on an arbor and the latter is placed upon thin disk rollers of the testing stand shown in Fig. 16. These disks are free to revolve so that any unbalanced or heavy part of the pulley will turn to the

bottom. This balance test is very sensitive as a slight irregularity in the distribution of the weight will cause the pulley to turn. As the pulley rim is of uniform section, the balance is, in most cases, very accurate and the use of counterweights is unnecessary.

Crowning Pulley Rims

"American" pulleys are made with either straight, cylindrical rims or with "crowned" rims which slope away from the center. The crowning is done on sizes above 48 inches, after the pulley is assembled and riveted together. The hydraulic press for doing this work is shown in Fig. 17. This press is equipped with sectional dies *A* which fit into a tapering seat in the outer ring *B* which is attached to the lower platen *C*

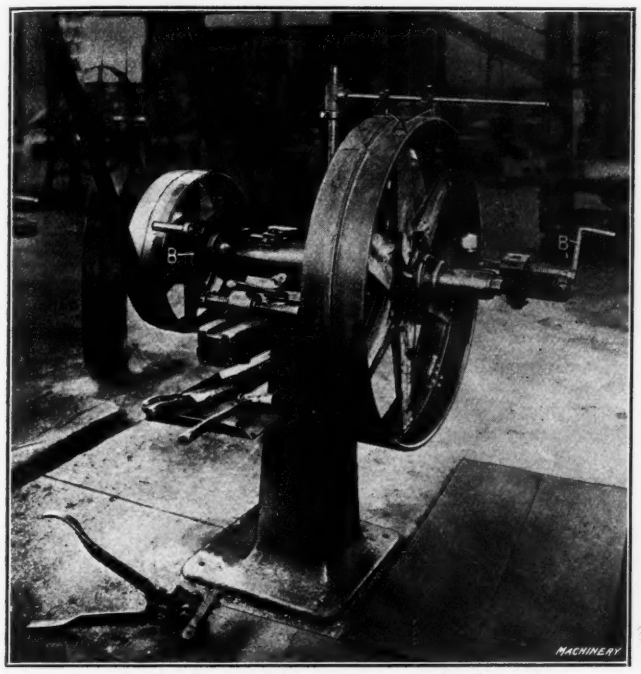

Fig. 15. Stand for testing Accuracy of Finished Pulley

of the press. The dies are also tapered on the inside to conform to the crown or taper required for the pulley rim. The pulley *D* to be crowned is first drawn up against the top platen of the press and is held there by a wire cable *E* operated by an overhead electric hoist. The lower platen or plunger then moves upward and the crowning dies are forced

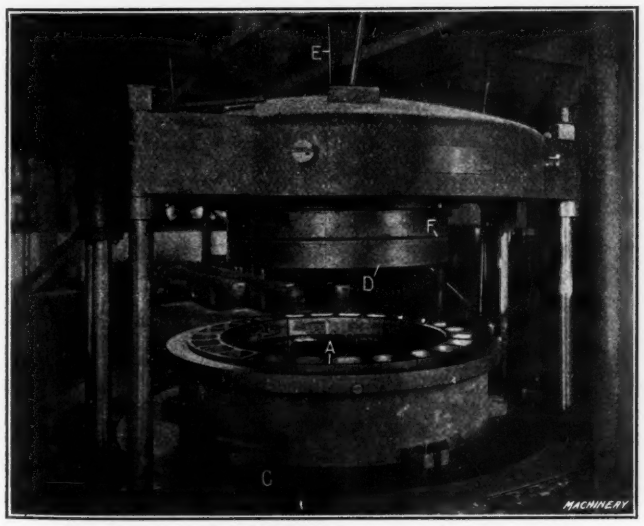

Fig. 17. Large Hydraulic Press and Dies used for crowning Pulley Rims

over the pulley, thus tapering one-half the rim. The platen is then lowered and the pulley is released by raising the sectional dies in their tapering seat. The opposite half is then crowned in the same way, the position of the pulley being reversed. Crowned rims are recommended for pulleys carrying non-shifting belts, and straight, cylindrical rims for belts that must be shifted.

The weight of one of these steel pulleys is about 45 per cent of the weight of a cast-iron pulley, and it is claimed that the strength is sufficient for any duty not so severe as to demand a special pulley. The annular groove *F* (Fig. 17) around the center of the rim face, formed by the curvature of the inner rim flanges, is said to greatly increase the efficiency of the pulley as a transmitter of power, owing to the fact that the air which is trapped between a rapidly moving belt and the pulley rim can escape through this groove, thus giving better belt contact.

* * *

CATALOGUE WASTE IN CENTRAL AMERICA

Special agent Garrard Harris writes that the waste of catalogues, trade circulars and form letters addressed to

Fig. 16. Stand for testing Balance of Pulley

merchants and business men of Central America, as well as other countries of Latin America, is enormous. Mails are loaded with beautiful catalogues that are works of art in every respect, exhibiting the most experienced thought and ability of experts. Most of the publications are illustrated and in the United States would prove valuable and effective

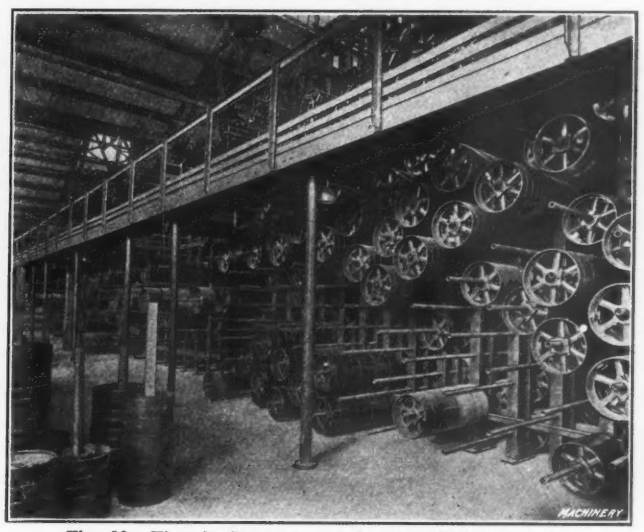

Fig. 18. View in Store-room of American Pulley Co.—Note Arrangement of Pulley Racks

trade getters. Yet in the Latin-American countries they are ineffective. Trade circular letters so prepared that a trained observer could hardly detect the mark of the mimeograph or the fact that each one was not an original personal letter also go to the waste basket. One reason is that all this trade literature is in English. Another is that Latin-American merchants prefer to do business with traveling men. Catalogues printed in Spanish, however, may be used effectively to introduce goods to the notice of possible buyers.

THE CLEVELAND AUTOMATIC SCREW MACHINE—1*

DESIGN, CONSTRUCTION, OPERATION, TOOL EQUIPMENT AND ATTACHMENTS

BY DOUGLAS T. HAMILTON†

The Cleveland Automatic Machine Co., Cleveland, Ohio, made the first model of the Cleveland automatic screw machine in 1891. This machine is constructed on the single spindle principle and incorporates many interesting features in design, construction and operation. One feature which characterizes it is the method of obtaining the variation in the feed of the turret and cross-slide tools. A regulating drum on which adjustable strip cams are held is used for this purpose; these cams operate a bell-crank lever which shifts the position of a roll located between two driving friction disks and thus changes the speed of the driving shaft operating the turret through spur gears, an epicyclic train and a worm and worm-wheel. This mechanism provides for a wide range of feeds to the individual turret and cross-slide tools and can be regulated while the machine is in operation. The latest improved model of the Cleveland automatic screw machine is shown in Figs. 1, 2, 3 and 4, which present front, rear and end views, respectively, of the 3¼-inch full automatic turret type of machine.

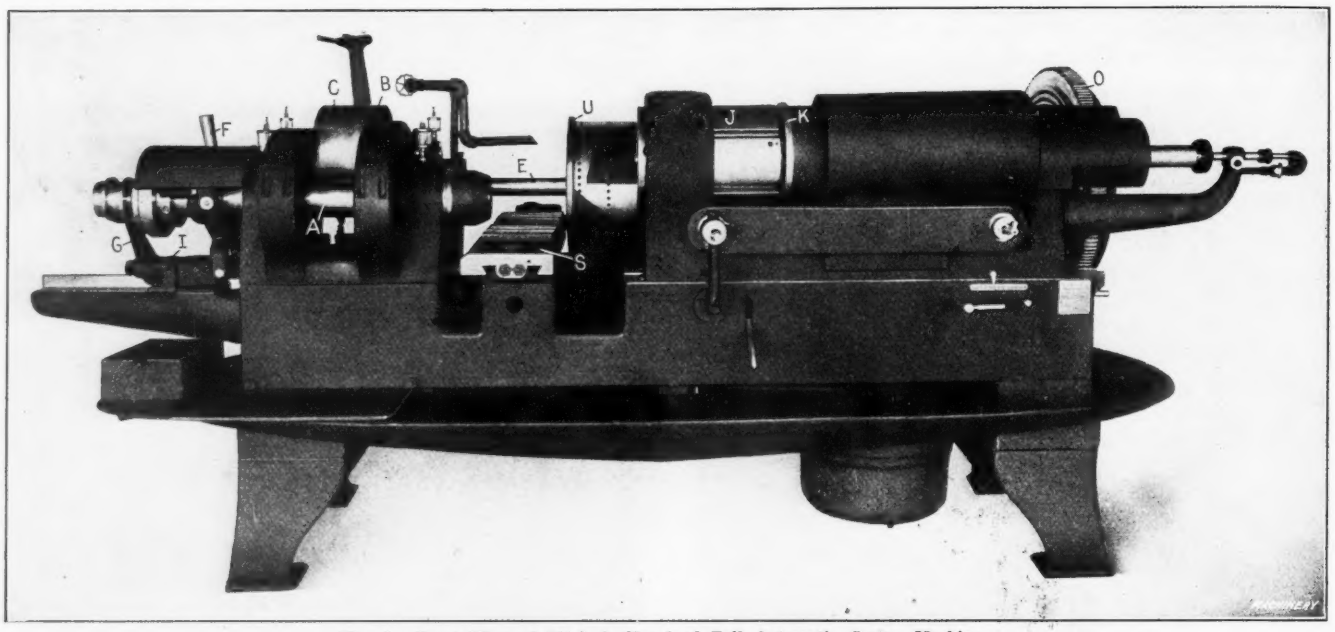

Fig. 1. Front View of 3¼-inch Cleveland Full Automatic Screw Machine

Types of Cleveland Automatic Screw Machines

In addition to the full automatic type of machine shown in Figs. 1, 2, 3 and 4, which is known as model A and is built in sizes ranging in chuck capacities from ⅜ inch to 7¾ inches, the Cleveland automatic is also built in several other types adapting it to a large range of work and variety of purposes. The full automatic machine is provided with a turret having five holes on sizes from ⅜ inch to 2¼ inches inclusive, and six holes on the machines of greater capacities.

The next type of machine is the plain automatic known as model B. This machine has no turret but is provided with one tool spindle which can be used for holding a box-tool, drill or tools of a similar character. The range of this machine, however, can be greatly increased by the addition of simple attachments on the cross-slides and tool spindle. The model C machine is of the full automatic type and is half-way between models A and B. It is provided with only three holes in the turret and resembles model B in construction.

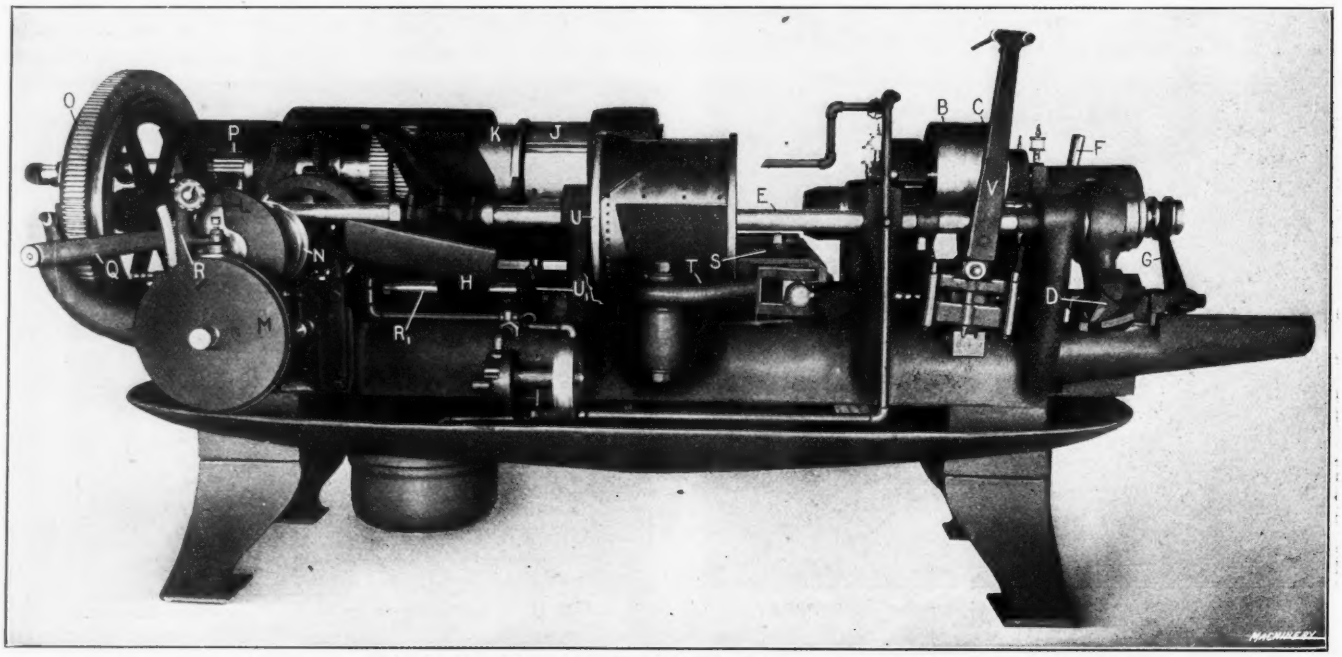

Fig. 2. Rear View of the Cleveland Full Automatic Screw Machine

* For information on automatic screw machine practice previously published in MACHINERY see "Examples of Screw Machine 'Set-ups,'" November, 1913, and articles there referred to.

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The type of machine known as model D is similar to model A, but is built to handle castings, forgings, etc., and hence is semi-automatic in its operation. The turret of this machine is provided with four holes and both the turret and spindle heads are adjustable along the bed. A modification of the plain machine is the double-spindle plain automatic which is provided with two opposing work-spindles located in a parallel line and with the chuck mechanism of both heads acting simultaneously. This machine is particularly adapted for finishing both ends of a piece of work, thus obviating the necessity of a second operation to complete the part.

Principles of Design and Operation

Before proceeding with the description of the construction of the Cleveland automatic screw machine, the general principles of operation will be briefly outlined. The following description given pertains particularly to the full automatic type of machine known as model A, as this machine incorporates all the principal points of design and operation common to this make of automatic screw machine. The work-spindle *A*, Fig. 1, is driven from the overhead countershaft through two pulleys *B* and *C* and three pinions (one being intermediate) and gears, two pinions being carried on the same shaft as the pulleys, one on an intermediate shaft, and the gears on the work-spindle. Pulleys *B* and *C* are separated by a loose pulley so that when the belt is thrown onto it no power is transmitted to the spindle. Pulleys *B* and *C* can be rotated both forward giving two speeds, or one forward and one reverse for threading. The chuck which is of the push type is operated by a sleeve that passes through the spindle and is actuated by adjustable cams held on the arm *D*, Fig. 2, located on the rear shaft *E*. Lever *F* is provided for opening and closing the chuck when setting up.

The feeding of the stock is accomplished by a feeding finger and tube passing through the work-spindle and operated by an arm *G*, see Figs. 2 and 3, which receives power through a rod R_1 actuated by the cam *H*. Variation in length of feed is accomplished by shifting the position of roll carrier U_1 along rod R_1. The turret *J*, which is of the drum type and is provided with holes for carrying six end-working tools, is mounted on a horizontal shaft located parallel with the spindle. It is operated back and forth by cams held on a separate drum *K*, which is rotated by spur gears, a worm and worm-wheel, epicyclic train and friction disks *L* and *M*; this mechanism receives power from a pulley *N* driven by a belt from the overhead works. The turret is indexed by a rod passing through the drum *K* which, when the turret moves back, comes in contact with pins held in its rear face, thus transmitting a rotary movement to the turret after the locking pin is withdrawn from the slots in its periphery by a cam held on drum *K*.

The feed given to the tools in the turret and on the cross-slides is governed by adjustable strip cams held on the regulating drum *O*, see Fig. 4, which is mounted on shaft *E* and rotated by a gear *P* held on the turret shaft. The cams on this drum operate a friction roll running between disks *L* and *M* through the medium of a bell-crank lever *Q* and rack arm *R*. The indexing of the turret is accomplished at a much higher speed than that used when cutting and this is effected by dogs carried on the regulating drum *O* which operate a tooth clutch, changing the drive direct to the pulley *N* instead of through the epicyclic train of gears mentioned.

The cross-slide which is a single casting *S*, carrying both the front and rear forming and cutting-off tools, is operated by a lever *T*. This lever receives its motion from cams held on drum *U* mounted on the rear shaft *E*. On the Cleveland automatic, as ordinarily equipped, the front and rear cutting tools cannot be operated independently, that is, they cannot be brought to work on the bar at the same time. However, for work which can be better handled in this way, a double cross-slide can be furnished as will be described later.

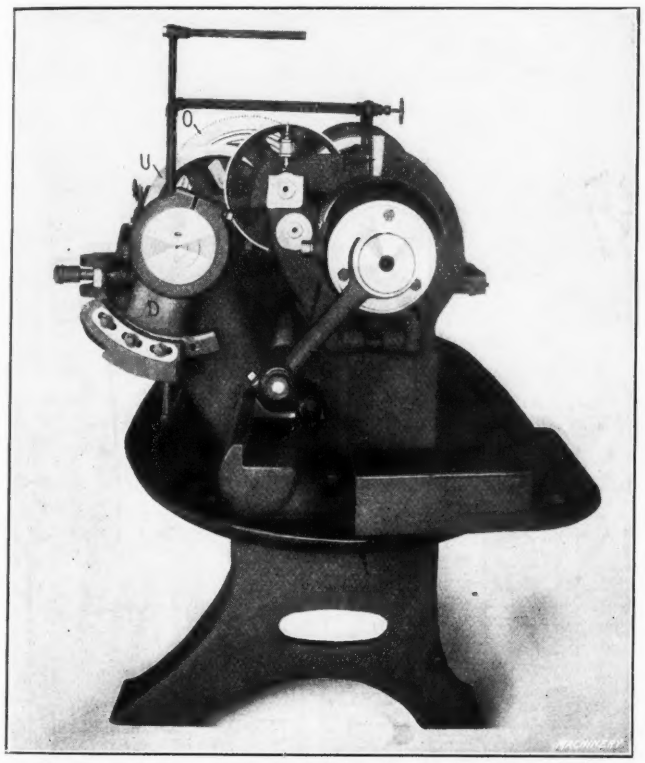


Fig. 3. End View of Cleveland Automatic showing Chuck Closing and Stock Feeding Mechanism

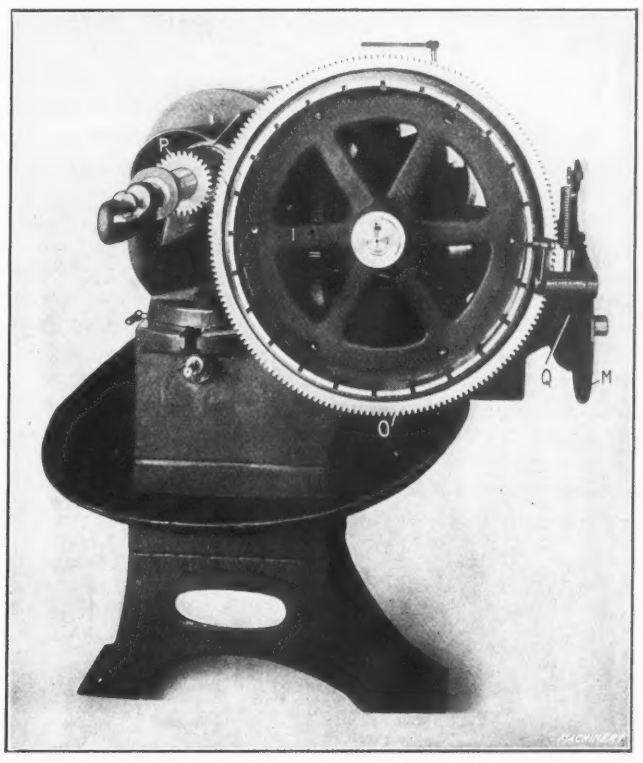


Fig. 4. End View of Cleveland Automatic showing Regulating Drum and Auxiliary Mechanism for changing Feed of Tools

Construction and Operation of the Work-spindle

The work-spindle *A* is a 0.40 per cent carbon steel forging that rotates in special journal metal bearings A_1, see Figs. 5 and 6. With the standard type of drive the spindle is rotated forward by pulley *B* through a pinion B_1 and gear C_1. It is revolved backward by pulley *C* through pinion D_1, an intermediate pinion and gear E_1. There are several other types of drives employed for special purposes, as will be described in a subsequent article.

The shifting of the driving belt from one pulley to the other is accomplished by an ingenious positive-acting belt shifting device *V*, which is shown in detail in Fig. 7. This device consists primarily of a bracket *a* fastened to a boss on the machine and carrying a swinging member *b* fulcrumed on a pin carried in the bracket. The device is operated to shift the belt to the different pulleys by means of cam fingers I_1, see Fig. 8, which are carried on the rear shaft *E* and are adjustable. The fingers, as the shaft rotates, come in contact alternately with spring operated plungers *c* and *d*, depressing them, and through the medium of levers *e* withdraw the wedge *f* from the slots in plate *g*. When the wedge *f* is withdrawn from one slot in the plate, the shifter is thrown instantane-

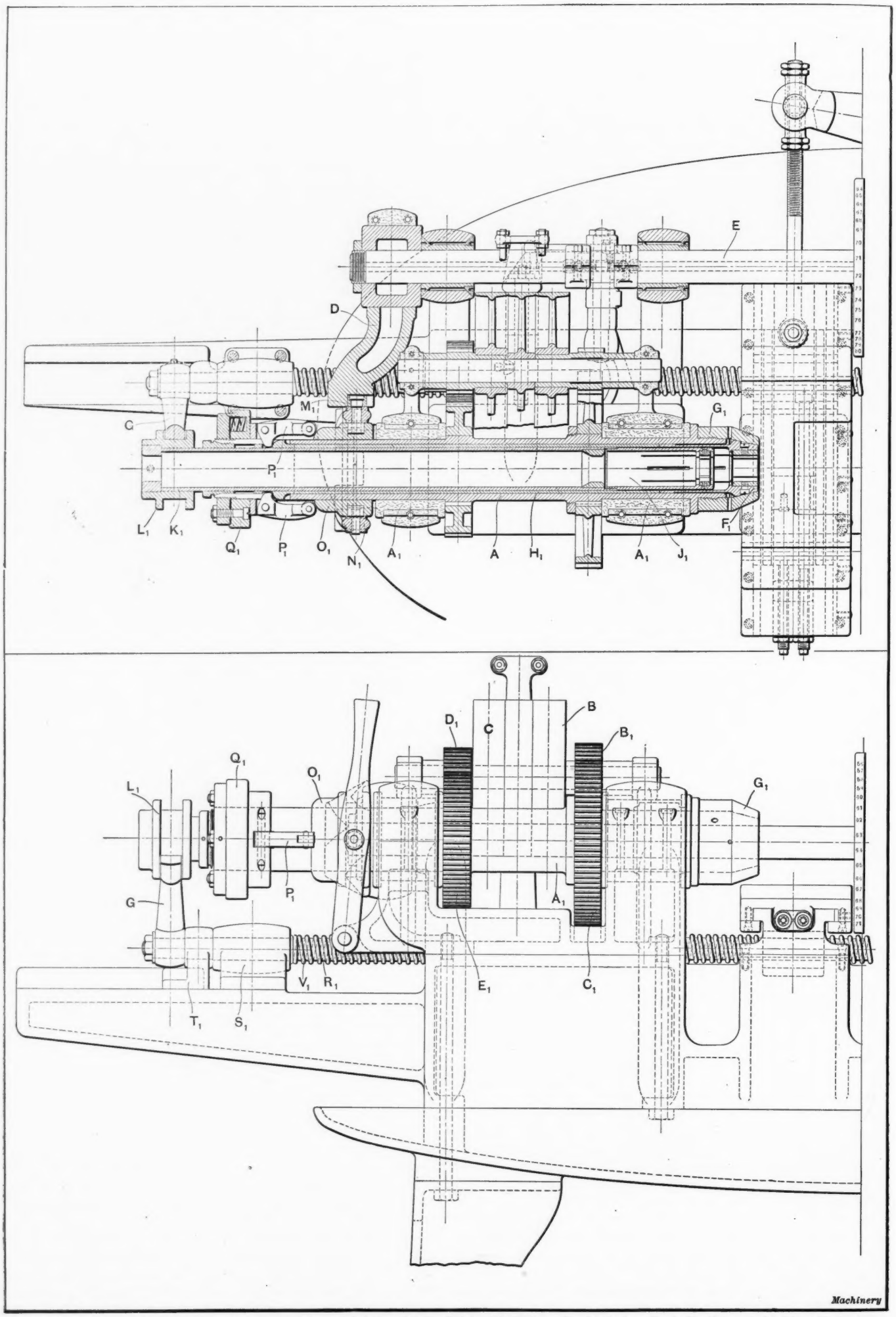


Fig. 5. Sectional Plan View showing Construction of Spindle, Spindle Driving Mechanism, Chuck Closing, Stock Feeding and Auxiliary Mechanism
Fig. 6. Front Elevation of Work-spindle End of Machine

ously into the next slot and thus shifts the belt or belts by means of the arm *h*. There are different combinations of these arms for the various types of belt drives and they can be easily changed by taking out the screw *i*. In Fig. 7, *h* is the arm and finger for the third speed drive, *j* for the double belt drive and *k* for the single belt drive.

Chuck Closing and Stock Feeding Mechanism

The chuck F_1, Fig. 5, which has a tapered nose, is of the push type and is held in the cap G_1 screwed onto the nose of

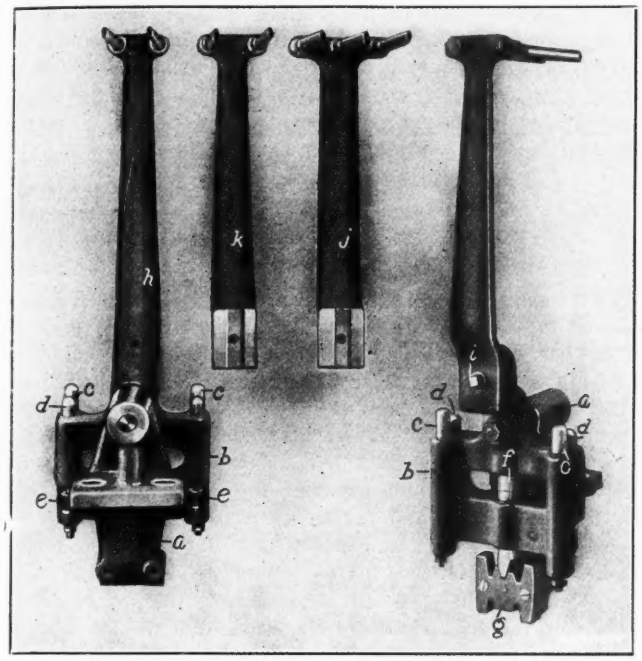


Fig. 7. Details of Positive-acting Belt Shifting Device

the work-spindle. It is operated by a sleeve H_1 that receives power from the arm *D*. A detail of this arm is shown in Fig. 10, which illustrates its adjustable features. In addition to being split, enabling it to be clamped in any position on the shaft, this arm is provided with adjustable cams *m*, *n* and *o*. Here *m* is the chuck opening cam, *n* the safety cam and *o* the chuck closing cam which is cast integral with the arm *D*. Cams *m* and *n* comprise the same casting and are adjustable on the arm *D*, being held in the desired position by three clamping screws fitting in elongated slots. There are also additional tapped holes in the arm allowing for further adjustment.

When smooth stock is being held in the chuck the adjustable cams *m* and *n* are set tightly up against cam *o*, thus giving a quick closing and opening action to the chuck and allowing a short space of time for feeding the stock. When rough bar stock is being handled, and for magazine work, it is necessary to keep the chuck open much longer; for this action the cams *m* and *n* are separated from cam *o* in order to allow sufficient time to handle the work successfully.

Fig. 10. Detail of Adjustable Cam Chuck Closing Segment

The action of closing the chuck is simple and is accomplished in the following manner: As arm *D* rotates, cam *m* comes in contact with a roll M_1, Fig. 5, held on the fulcrumed yoke N_1. This yoke, in turn, carries two rolls that work in a circular groove cut in sleeve O_1. As the cam forces this sleeve in a direction away from the chuck it acts upon two fingers P_1 provided with rolls at their outer ends, the rear ends of the fingers bearing against the rear end of the chuck closing sleeve H_1. This action forces the split chuck into the hood closing it on the work. As cam *o*, Fig. 10, comes into action, it reverses the operation of yoke O_1 and removes the pressure from the sleeve H_1, allowing the chuck to open, due to spring tension. Pressure bushing Q_1 acts as a medium for holding the fingers P_1 up on the collar O_1.

The bar stock is fed through the spindle by a spring finger J_1 screwed into the front end of the tube K_1, the rear end of which is provided with a grooved collar L_1. Fitting in this grooved collar is a forked lever *G* which is carried on the rod supported in brackets S_1 and T_1, the former being fastened to and the latter sliding on the base or extended bracket on

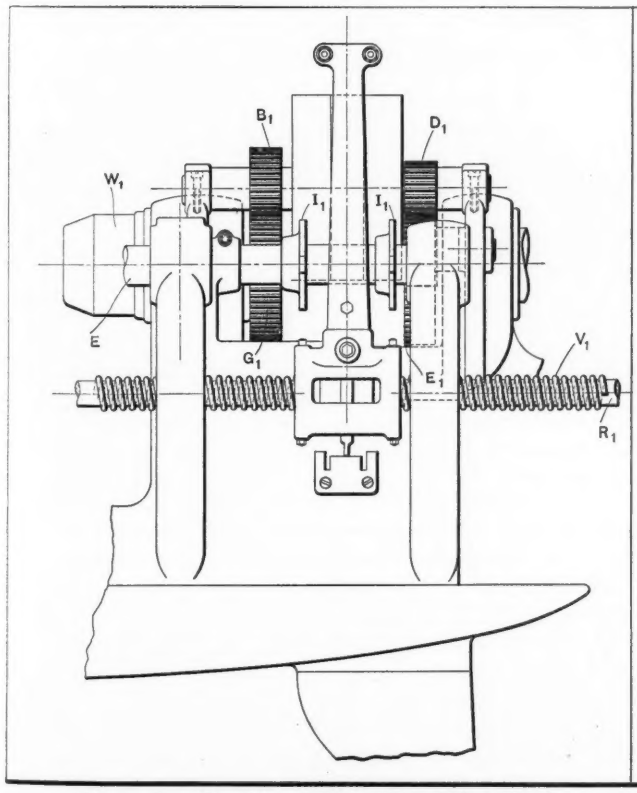


Fig. 8. Rear Elevation of Work-spindle End of Machine showing Drive and Belt Shifting Arrangement

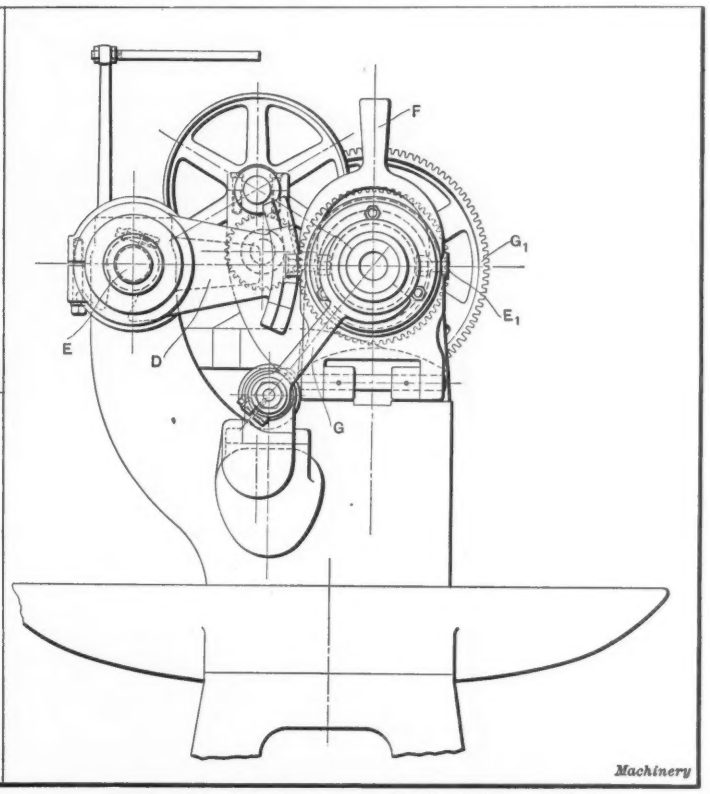


Fig. 9. End Elevation showing Chuck Closing and Stock Feeding Mechanism

the machine. The movement of forked lever G is controlled by a cam H, Fig. 2, which contacts with a roll held on bracket U_1 clamped to rod R_1. Adjustment for length of feed is controlled by shifting the position of the bracket U_1 along rod R_1, and the timing is effected by shifting the cam H around the shaft E. An open wound coil spring V_1, Fig. 6, serves to keep the forked arm G and sliding bracket T_1 up against the stationary bracket S_1, when the rod R_1 is not acted upon by the cam. For double feeding, a drum is provided carrying two cams, allowing for feeding the stock twice for every revolution of the cam-shaft.

* * *

"FAST" SPEED REDUCING MECHANISM

The accompanying illustration shows a new type of high-speed "transformer" or speed reducing mechanism invented by Mr. Gustav Fast. As will be seen, this device is an application of the friction gear principle. The motion is transmitted from the cylindrical sleeve A on the high-speed shaft, to five rolls B (see end view) which are carried by housing D connected with the low-speed shaft.

The novel feature of this mechanism is that the frictional rolls B are flexible, being made in the form of a helical spring in order to insure an even contact between the inner and outer members A and C against which they bear as they revolve. The outer part C is also made in the form of a helical spring and it is enclosed by a sleeve E that is tapering on the outside. When this sleeve is drawn in by means of the threaded end and worm gearing shown, the diameter of the flexible track for the rollers is reduced. This construction is said to insure a perfectly cylindrical surface even when this flexible lining is contracted to its limit, which equals a reduction in diameter of 1/16 inch. By means of the adjusting worm gear, sufficient pressure can easily be obtained for any load within the capacity of the mechanism.

The speed reduction of the particular design illustrated is in the ratio of 3½ to 1, but this type of speed reducer can be designed for ratios varying from 2½ to 1 up to 10 to 1. It is claimed that the transformer runs very smoothly and quietly at speeds even as high as 6000 revolutions per minute and that it makes considerably less noise than a steam turbine or an electric motor running at the same speed. The total weight of the machine is 218 pounds. The maximum power that a speed reducer of the type here shown is capable of transmitting at various speeds is as follows:

Speed of "High-speed" Shaft, R. P. M.	Horsepower Transmitted	Speed of "High-speed" Shaft, R. P. M.	Horsepower Transmitted
1000	11	4000	34
2000	21	5000	38
3000	28	6000	40

In the construction of this speed reducer, heat-treated vanadium steel proved to be an important factor in making the device efficient and practicable. The high wearing qualities of chrome-vanadium steel tires led the inventor to use vanadium steel in this transformer for the driving roller, the friction rollers and the flexible track or casing. After using the transformer six months, the parts showed practically no wear and the surfaces were very hard and smooth. The vanadium steel used was made by the Halcomb Steel Co., and it is the type D, 0.50 carbon chrome-vanadium steel.

The heat-treatment given these parts is as follows: All of them were quenched in oil at 1650 degrees F.; the driving roller was then drawn at 650 degrees F.; the friction rollers at 450 degrees F.; and the flexible track at 800 degrees F. It is claimed that the efficiency obtained with this mechanism has been as high as 99 per cent and that it has never dropped below 97 per cent for any kind of a load. The mechanism has been loaded to 100 per cent above its capacity for a continuous run of three hours without being injured.

* * *

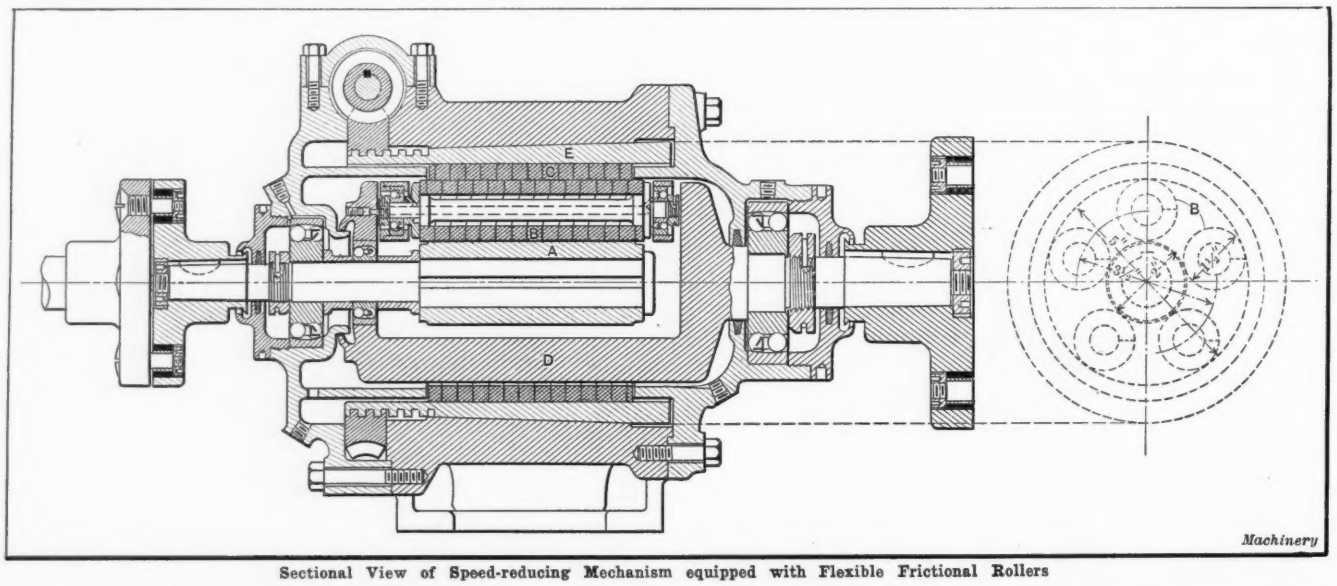
NEW DEPARTURE IN ENGINEERING EDUCATION

An interesting educational experiment will be made this year at the College of Mechanical and Electrical Engineering of the State University of Kentucky, where the thesis of the students of the senior class will consist of a complete design with specifications for a 15,000 kilowatt power plant, not worked out individually by each student, but by the students as a group of engineers. A location will be definitely decided upon and the young men will visit the spot, making an actual preliminary survey and boring a few test holes. They will also investigate the water supply and the climatic conditions where the plant is to be located. After the preliminary work has been done, the class will be organized into an engineering body working in a class drafting-room like in a modern engineering establishment, with a regular eight-hour working day. It is stated that even a time clock will be installed and that regular attendance to duties will be enforced. One of the professors will act as chief draftsman, the man being selected to act in such capacity having had experience in the office of a large power plant designing firm.

This new departure in engineering education is worthy of commendation. It seems to place the engineering college on more practical ground and to make the transition stage between school and practical engineering work easier than has been the case in the past, when many graduates have entered practical work with little or no knowledge of actual engineering conditions.

* * *

According to the *London Times*, a bill will shortly be introduced in the French Chamber of Deputies making legal the division of the quadrant of a circle into 100 parts, or grades, each divided into 100 centesimal minutes, each of these, in turn, consisting of 100 centesimal seconds. According to this division a complete circle will have 400 grades, 40,000 minutes, or 4,000,000 seconds.



Sectional View of Speed-reducing Mechanism equipped with Flexible Frictional Rollers

ELECTROPLATING ZINC ALLOY DIE CASTINGS

Difficulty has sometimes been experienced in electroplating zinc alloy die castings, although they can be electroplated as easily as iron or steel if the proper methods are followed. The following, which is from a booklet on this subject issued by the National Lead Co., New York City, contains some practical methods whereby die castings can be cleaned, polished and electroplated.

Cleaning and Polishing

Die castings that are to have a polished surface should be "cut down" with the usual buff wheels and tripoli composition. The finishing should be done with white compositions of Vienna lime. After the parts have been polished, the excess of polishing material should be removed by the aid of benzine or gasoline, and they should be dried in maple sawdust. If the benzine or gasoline is dispensed with, hot alkaline solutions should be used for cleansing. The strong alkalies of caustic soda or potassium should never be used in cleansing zinc, as they have a reducing action upon the metal and produce oxides, thus destroying the polished surface.

The solution should be maintained at a temperature of 160 to 180 degrees F. Soda ash may also be used for the purpose, one pound of this material and one-quarter ounce of cyanide of potassium being used per gallon of water.

The articles should remain in the cleansing bath for a few minutes and then the excess polishing material brushed away, using an oval painter's sash brush for the purpose; the rubber-set variety is the most economical. After cleansing, immerse in clean, cold water and then into a cyanide dip. This dip should consist of 6 ounces of cyanide of potassium or sodium to each gallon of water and should be used cold. After re-washing the articles in clean, cold water they are ready for the plating bath.

Articles to be unfinished are cleansed in the same manner, if somewhat corroded due to the formation of oxide of zinc on the surface by contact with moisture. Immerse for a few seconds in a pickle consisting of one part of hydrochloric acid and four parts of water (this will dissolve the oxide); then rinse the die castings in cold water, immerse in the cleaning solution for a few seconds, re-wash in cold water and scratch-brush to bring up the color of the metal. Repeat the cleaning operations, using only the cleaning solution and the cyanide dip; the casting is now ready for plating. If the articles are to have a polished finish, the scratch-brushing may be dispensed with.

Copper-plating Die Castings

The solution for copper-plating should have the following proportions:

Water	1 gallon
Cyanide of copper	3 ounces
Carbonate of potash	1 ounce
Cyanide of potassium or sodium	4 ounces

To prepare the solution, the potash and copper should be dissolved in half the amount of hot water, the cyanide in the balance of lukewarm water; then mix thoroughly together. Use the solution at a temperature of 150 degrees F. and at 2 to 2½ volts pressure. Cast copper anodes give the best results, but the electrolytic variety may be used.

Brass-plating Die Castings

Prepare a solution exactly the same as for the copper bath; then dissolve equal parts of cyanide of zinc and cyanide of potassium in warm water. An addition of 1 ounce of zinc carbonate and the same proportions of cyanide should be added to the copper bath per gallon; then add ½ ounce of sal ammoniac per gallon of solution. If the color should be too deep a yellow, a little more zinc should be added to the bath to obtain the required shade. This bath should be used at a temperature of 120 degrees F. and at 2 to 3 volts pressure. The cleansing of the articles should be done as previously stated.

Nickel-plating Die Castings

Much trouble has been experienced in nickel-plating die castings with the ordinary solution, due to black streaks appearing in the deposit caused by local action of the ordinary solution upon the metal. The following formulas will give satisfactory results without the difficulties mentioned:

Nickel sulphate	10½ ounces
Potassium citrate	7 ounces
Ammonium chloride	10½ ounces
Water	2½ gallons

To prepare this bath, dissolve the nickel sulphate and ammonium chloride in half the amount of hot water prescribed; then dissolve the potassium citrate in the balance of the water and mix thoroughly. The voltage should be 2½ to 3 volts. This bath should always be kept neutral to avoid black streaks. For this purpose pure caustic potash dissolved in water should be added to the bath so that the solution is neutral to the test of red or blue litmus paper.

The following bath is used extensively in plating articles made from zinc and gives excellent results:

Double nickel salts	8 ounces
Chloride of sodium	1 ounce
Magnesium sulphate	2 to 4 ounces
Water	1 gallon

To prepare the bath, dissolve the nickel salts in half of the water at a temperature of 180 degrees, and dissolve the other salts in the balance of cold water; then mix thoroughly together. Use this solution cold, with anodes of cast nickel. The voltage should be 2½ to 3½ volts. The articles to be nickel-plated may be plated direct or be lightly coated in the copper or brass baths prior to nickel-plating. The time of immersion in either of the nickel baths should be according to the thickness of the deposit required, although thirty minutes gives a fairly good deposit in either case.

Silver-plating Die Castings

Cyanide of silver	3 ounces
Cyanide of potassium	4 ounces
Water	1 gallon

Use anodes of pure silver at about 1 volt pressure. Die castings for silver-plating should be previously copper-plated for a short time then amalgamated in a mercury dip consisting of the following proportions:

Water	1 gallon
Oxide of mercury	½ ounce
Cyanide of potassium	6 ounces

After copper-plating and washing in water, the articles are immersed in the dip for a second or two, or until uniformly coated with mercury. They should then be re-washed and immersed in the silver bath. The articles may also be nickel-plated in one or the other of the nickel baths and then quickly coated in the silver striking solution, after which they should be directly immersed in the silver bath without rinsing.

The silver strike should be as follows:

Cyanide of silver	½ ounce
Cyanide of potassium	6 ounces
Water	1 gallon

Use silver anodes with 3 to 4 volts pressure. The nickel surface must be immediately coated over for successful silver deposits.

Gilding Die Castings

In gilding die castings the articles must be previously coated with brass or copper and have a bright luster. The following formula will give excellent results:

Phosphate of soda	8 ounces
Sulphate of soda	1½ ounce
Cyanide of sodium	6 pennyweights
Chloride of gold	6 pennyweights
Water	1 gallon

To prepare the solution dissolve the cyanide and chloride of gold in part of the hot water and the sodium salts in the balance; then mix together thoroughly. Anodes of gold, platinum or carbon may be used, and the bath should be kept at a temperature of 180 degrees F. at 2 volts pressure. If the articles are previously coated in the copper bath they should afterward be flashed in the brass bath to save an excess of gold.

The usual lacquers should be applied to brass, copper, silver or gold finishes. In plating die castings or articles of zinc, it is a distinct advantage to use as little free cyanide as possible. If this is reduced to a minimum, very little difficulty will be experienced in the blistering of the deposit. In nickel-plating, the baths should be maintained at the neutral point, as previously mentioned.

WORM HOBBING ATTACHMENT FOR AUTOMATIC SCREW MACHINES

DETAILS OF THE DESIGN OF THE ATTACHMENT AND METHOD OF MAKING THE HOB

BY B. F. ALEXANDER*

The Warner Instrument Co., Beloit, Wis., now incorporated under the name of the Stewart-Warner Speedometer Corporation, was the first to use an attachment on a National-Acme automatic screw machine for hobbing worm and spiral gears from blanks formed from bar stock on this machine. The first idea of making such an attachment is credited to Mr. A. B. Cadman, superintendent of the Beloit factory of the Stewart-Warner Speedometer Corporation, and formerly of the Warner Instrument Co. It has since been developed into many different types, the latest of which is the one described in this article. To show that these attachments are quite practical and not in any sense experimental, I might add that the first attachment that was made is still in actual service, having been used over a period of four years. During this period it has hobbed thousands of spiral gears.

The following describes a drop feed attachment—the first of its kind to be made—and a glance at Fig. 1 will give the reader an idea of the worm. It will readily be seen that the design of this worm is such that it could not be handled by

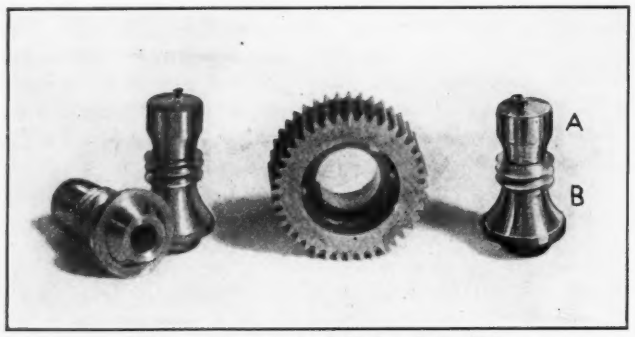


Fig. 1. Worm to be hobbed and the Hob

a circular hob fed longitudinally, and that is the reason a drop feed is used. By calculation, it was found that forty teeth would give a hob of the diameter that would clear the two high points on the worm blank, marked *A* and *B* in Fig. 1, and this number of teeth on the hob determines the entire gearing of the attachment. The worm being of the single threaded type, and the hob used to produce it having forty teeth, it follows that the worm must make forty revolutions to one revolution of the hob. Now then, the chucking spindle holding the worm blank must make forty revolutions to one revolution of the hob, which is driven by an extra shaft geared to the center spindle of the machine at the back or pulley end. Having the ratio given between the speed of the chucking spindle and the center spindle, which in this case is 29 to 36, the shaft *B* in Fig. 3 must revolve at the same speed as the chucking spindle. The 40 to 1 reduction is obtained through the worm on this shaft and the worm-wheel on the hob spindle. In Fig. 3, *D* shows the worm-wheel and *C* the worm keyed on the shaft *B*. On the No. 53 machine fitted up for this job, a 29-tooth pinion on the center spindle drives a 36-tooth gear on each chucking spindle. Therefore a 29-tooth pinion *A* is keyed on the center spindle on the back end of the machine and drives a 36-tooth gear *C* on the shaft *B* as shown in Fig. 4, with any idler *D* that conveniently meshes with the two gears *A* and *C*.

The Feed

The attachment is so designed that the hob starts hobbing the worm as soon as the forming tool begins to form the blank. Since the worm *C* and the worm-wheel *D*, Fig. 3, drive the hob at the required speed, and as their relative positions cannot be changed without altering the speed of the hob, it is evident that the center of the worm *C* must be the center about which the hob spindle oscillates. The worm can drive the worm-wheel *D* keyed on the hob spindle at the same speed in any position of the hob. The hob spindle is carried in bearings on an independent plate *H* which swings back and forth about the center of *C*, Figs. 3 and 5, on the surface of the casting *I* that is bolted down on the screw machine head. A cam *E* is mounted on the forming tool cross-slide to raise and lower the hob. An arm on the casting *H* has a roll *F* that fits in the cam *E*, and thus the raising of roll *F* by cam *E* lowers the hob and *vice versa*.

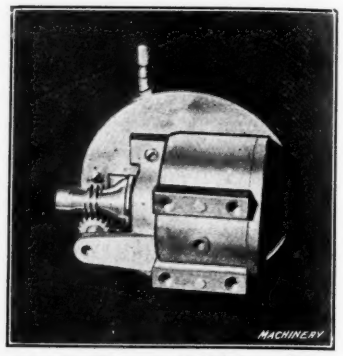


Fig. 2. Worm in Position on Case of Auto-meter

Fig. 6 shows the cam *E* more clearly. From *B* to *A*, the cam lets the hob drop quickly down to the surface of the worm, and this drop occurs when the cross-slide of the machine moves in quickly until the forming tool starts to cut. This action of the cross-slide reduces the time required to feed in by sliding in quickly to the point where the forming tool begins to cut. The tool then has more time to feed in and do the forming at a slower feed, thus producing a more perfectly finished blank. For this reason the cross-slide was selected to feed the hob on this attachment, and obtain the same action for the feed of the hob as for the feed of the forming tool. When the roller *F* has passed up the sharp incline *B*, Fig. 6, the cross-slide is just beginning to feed in slowly and the hob is just touching the blank; then the roller starts up the incline *A* at a slow speed, thus feeding the hob down into the blank to the required depth at a very slow feed. No spring or weight is required to lift the hob out of the hobbed worm, as the cam *C* performs this function by lifting the hob high enough to clear the machine's chucking spindle carrying the hobbed worm, allowing it to swing around a quarter of a revolution to its next position for the drilling operation.

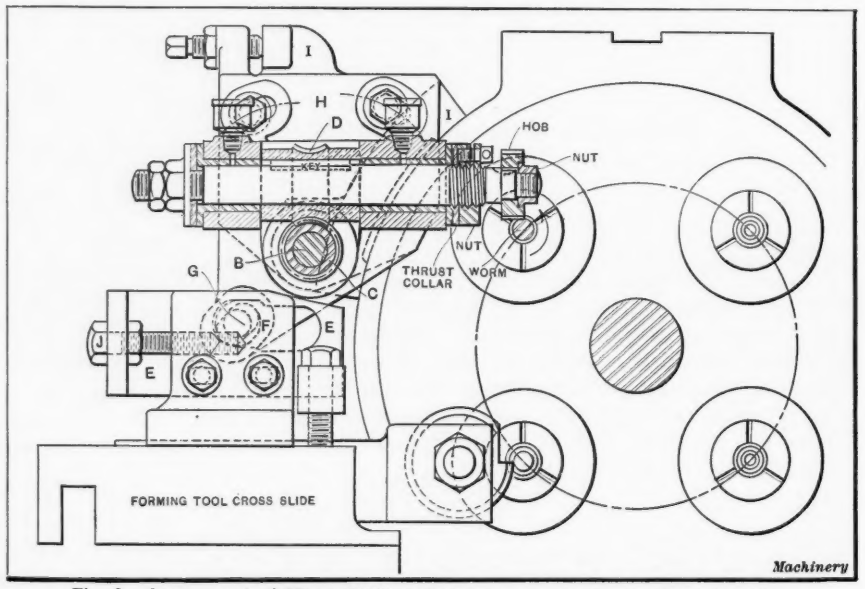


Fig. 3. Arrangement of Worm Hobbing Attachment on Automatic Screw Machine

Not being certain of the accuracy of the scaled dimensions of positions of the machine's parts and the outside diameter of the worm being subject to a change, the cam *E* was made adjustable. By sliding it in or out by the screw *J*, Fig. 3, various diameters of a 0.098-inch lead single threaded worm may be hobbed, providing that the variation does not amount to enough to change the spiral angle sufficiently to interfere

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with the angle the teeth in the hob are cut on. However, considerable variation in the diameter of the worms to be hobbed can be taken care of. The face of the hob being flat and tangent to the worm, there is considerable clearance between the sides of the teeth on the hob and the sides of the threads on the worm in back of the cutting surface of the hob. This clearance increases as the curvature of the worm gets farther from the toothed face of the hob. This is evident, in that the teeth get narrower at the top, and the space between becomes wider.

The hob spindle is made adjustable to compensate for the regrinding of the hob. By loosening the nuts on the back end of the spindle from the steel thrust collar, the clearance may be taken up by tightening the lock-nut on the hob end, thus pulling the spindle forward. The key for the worm-

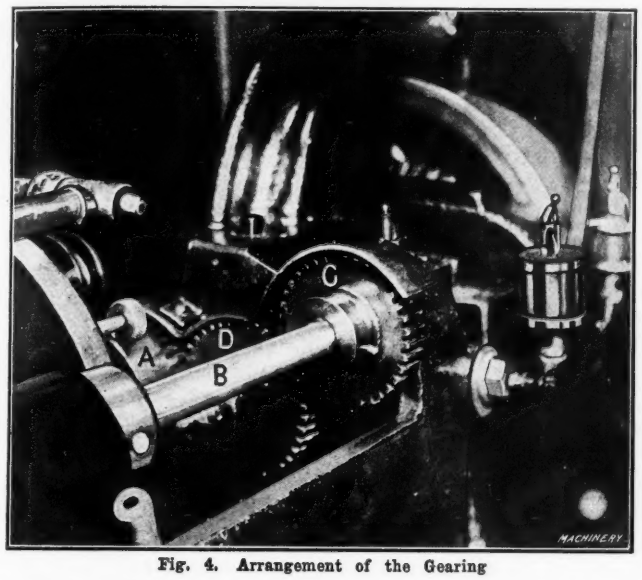

Fig. 4. Arrangement of the Gearing

wheel is solid in the spindle and has ample room between the bearings to allow it to slide in the worm-wheel either way. The spindle runs in hardened steel bushings, the back bushing being clamped in the casting *H* while the front bushing is pressed in. The back bushing is clamped in place because in changing the spindle or taking it down for repairs, this bushing must be readily withdrawn to permit the key in the spindle to be drawn through the bearing boss.

The Making of the Hob

To make the generating hob another hob is required to cut the teeth with, this hob being similar to the one used in hobbing a worm-wheel. In fact, the relation between these two hobs is the same as between a worm and worm-

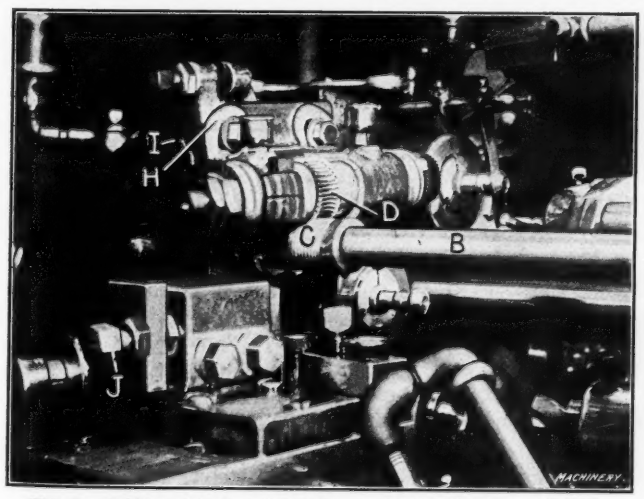

Fig. 5. Hobbing Attachment in Place on Automatic Screw Machine

wheel. This hob for producing the teeth in the generating hob used on the fixture is made to the same dimensions as the worm to be hobbed. It is thus evident that the generating hob will reproduce a worm of the same form of thread as that of the hob that produced the teeth in it. We have, however, a slight exception in this case, in that the hob takes a drop cut in the worm blank, thereby leaving a curve on the threaded length of worm with a radius equal to half the diameter of the hob—in other words, producing a worm somewhat of the Hindley form. No advantage in this shape of worm is gained, however, as the worm-wheel driven by the worm is much smaller in diameter than the generating hob.

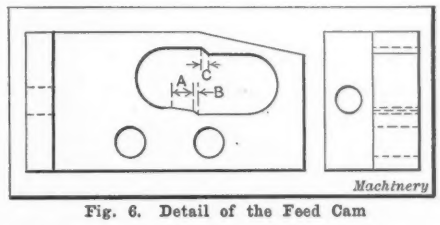

Fig. 6. Detail of the Feed Cam

Fig. 9 shows the worm shaped hob for producing the teeth in the generating hob. It is made up with a standard taper shank to fit the milling machine spindle, and is very substantial at the hob-end to prevent any vibration or spring, although the center may be used when the tool is in operation, thus eliminating all chance of chatter. The threaded length of the hob must be the same as for a hob used for hobbing a worm-wheel of the same dimensions as the generating hob. In other words, if the threaded length of the hob were shorter than the length engaged by the teeth in the generating hob, good results would not be obtained. The thread was cut in a lathe with a 29-degree formed tool, the lead of the thread being 0.098 inch and the depth 0.068 inch. The thread is single, the same as the finished worm. After the thread was cut, the hob was fluted and the top of the teeth and the bottom of the spaces relieved by hand. It was then hardened and tempered. The next step was to make a gashing cutter to gash the generating hob blanks with. This cutter is circular and is of the 29-degree form—

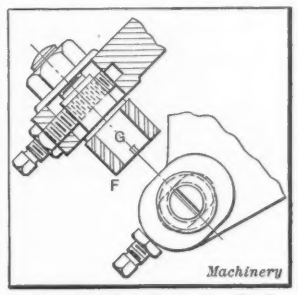

Fig. 7. Detail of the Feed Roller and Arm

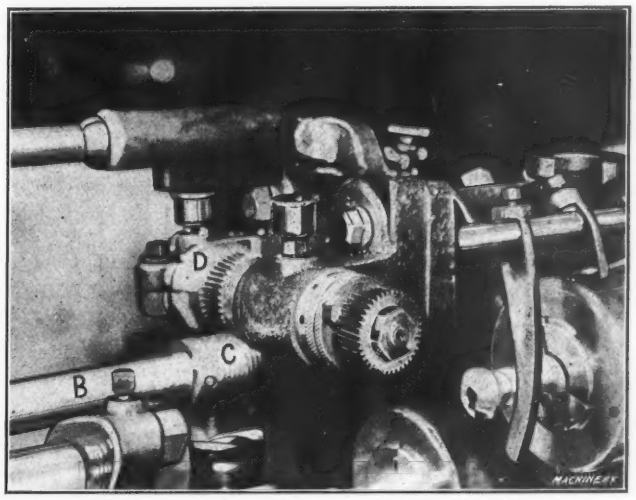

Fig. 8. View of the Hob in place on the Attachment

14 degrees, 30 minutes on a side—with the calculated width of face. Teeth were cut and relieved in it and the cutter was then hardened and tempered ready to gash the blank.

Having the hob and gashing cutter made, we may go ahead and make the generating hob blank. The finished piece is to have forty teeth and the circular pitch is the same as the lead of the worm. The pitch diameter can be found by calculation, but the outside diameter cannot be determined by the calculation used in finding the throat diameter of a worm-wheel of 40 teeth and 0.098 inch circular pitch. This is due to the fact that the dedendum of the worm must be added twice to the pitch diameter of the hob to obtain the outside diameter. In brief, the dedendum of the worm is the addendum of the hob. The hob is designed to stand considerable regrinding. It will therefore "stand up" comparatively long and hob thousands of worms before it must be discarded. Stock is left on to grind by, making the toothed face wider than the length of the spindle bearing

through the center. The difference of the two widths equals the amount that may be ground off before the hob must be discarded. In this case 3/16 inch was left on the flat face to be ground. The toothed face is 9/16 inch wide and the length of the spindle bearing in the center ⅜ inch, thus leaving a counterbore 3/16 inch deep and large enough in diameter to clear the flanged nut that holds the hob on the spindle.

The grinding of the hob after the edges of the teeth have become dull is a very simple matter. Simply lay the hob flat on a magnetic chuck on a surface grinder, with the cutting side up, and grind across the surface. About 0.002 to 0.005 inch is generally sufficient stock to grind off; this will sharpen the cutting edges of the teeth and the hob will be as efficient as ever. A good feature of this method of grinding is that the two faces of the hob are always parallel after grinding; consequently the cutting edge runs true with the spindle. It must be clearly understood that the toothed face has no clearance, being made parallel with the spindle hole in the center. Otherwise the grinding would be a detriment, as the hob would be smaller in diameter after each grinding, and would, therefore, require readjustment of the hobbing fixture. Clearance on the face would also complicate the cutting of the teeth of the hob with the equipment of an ordinary tool-room. I doubt if it could be done successfully. However, it is not necessary, and not enough advantage would be obtained to balance the extra expense and trouble in making a hob of this type. I might add that the Stewart-Warner Speedometer Corporation grinds all hobs of this type on magnetic chucks and has not yet experienced any serious trouble from the hobs becoming magnetized from the chucks.

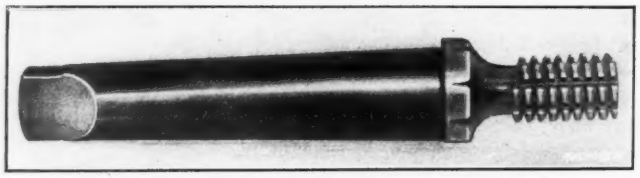

Fig. 9. Worm-shaped Hob for producing the Teeth in the Generating Hob

The gashing of the blank can be done by the usual method employed for gashing worm-wheels with flat faces. This consists of moving the table of the milling machine around to the required gashing angle and feeding the blank across the gashing cutter. When greater accuracy is required, this company employs a different method, as given in the following: Put a plate under the index head, leaving the table set at zero, and swing the plate with the index head around to the required angle. This arrangement allows the table to be fed across in the same plane as the gashing cutter. If the gashing is done by swinging the table around, the blank is fed against the cutter on an angle, thereby getting a gash that is not of the same form as that of the gashing cutter. It must be understood that the face of this hob is flat and not concave, and that it has to be gashed across the entire face at the same depth.

After the blank has been gashed, the index head is set back on the table in its usual position, and the gashed blank placed on an arbor and set up between centers so it can turn freely without any end-play. Put the hob for cutting the teeth in the spindle, raise the blank up to it and enter for the full depth of teeth; then feed across the hob. It is understood, of course, that the worm-hob carries the gashed blank around, similarly to the way a worm carries a worm-wheel around. A mark should be scratched on the blank, so that every time the blank has made one revolution the table can be fed in about 0.020 inch. This method gives a tooth of uniform shape across the entire face. All that is now left to be done is to harden the hob and temper it. It is then ground on the flat cutting surface, ready for use.

* * *

It is stated that liquid air can be produced at the rate of from 3 to 8.5 cubic inches per horsepower hour, according to the apparatus and arrangements employed.

SLIDING ACTION IN BALL BEARINGS

BY M. TERRY*

The popular impression regarding ball bearings is that in order to secure rolling contact, the contact points of the balls on the races should be points on a cone of rotation, the apex of which lies in the center line of the shaft, or that they should be points on the surface of an imaginary cylinder, the elements of which are parallel to the center line of the shaft. These purely geometrical considerations constitute a very elementary analysis, and when our theory is extended to embrace a few laws of mechanics and elasticity of materials, it becomes apparent that there is, perhaps, no such thing as pure rolling action, but only an approach to it; and—other things being equal—the degree of approach to the true rolling action determines the quality of the bearing.

Cup and Cone Bearing

Fig. 1 shows a cup and cone type of bearing with points of contact *a* satisfying the geometrical requirements. A point may be considered as an area of a circle of an infinitesimal diameter. If the load be applied and the points of contact are to remain mere points we shall have the condition of a measurable load distributed over an infinitesimal area which would result in an infinite stress per square inch. Such a condition is, of course, impossible, and deformation of balls and races will take place with the points of contact gradually widening into measurable areas of contact—probably circular or elliptical in shape.

In Fig. 1, *b* and *c* are the limiting points of contact, and whether the line *bac* be a straight line or a curve, the symmetry of the design suggests that points *b* and *c* are equally distant from the axis of rotation of the ball. The ball has a motion similar to that of the earth, *i. e.*, it revolves in an orbit determined by the inner and outer races and at the same time it rotates about its own axis. Assuming that in completing one revolution about the axis of the shaft the ball makes N rotations about its own axis x—x and that there is absolutely no sliding, we can write the following equations:

$$2\pi rN = 2\pi R_1; \text{ and } 2\pi rN = 2\pi R_2.$$

Therefore R_1 should be equal to R_2, which in this type of bearing is a constructive impossibility, and hence sliding proportional to the difference between R_1 and R_2 must take place. Similar sliding action also occurs on the inner race.

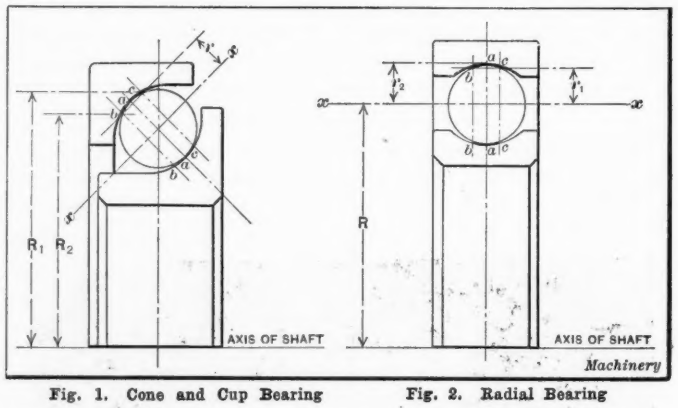

Fig. 1. Cone and Cup Bearing Fig. 2. Radial Bearing

Radial Bearing

Fig. 2 shows a radial bearing under load. If the lines of contact *bac* were straight lines, pure rolling action would be possible, but as a rule lines *bac* are curves the radius of curvature of which increases with the size of the ball. The amount of sliding in this type of bearing depends largely on the ratio $\frac{r_1}{r_2}$; the closer this ratio approaches the value of unity, the less is the sliding action. Let N, as before, represent the number of rotations made by the ball about its own axis while revolving once about the axis of the shaft. Then, from Fig. 2 and assuming pure rolling of points *b* and *a* on the outer race, we have:

$$2\pi r_1 N = 2\pi (R + r_1) \quad (1)$$

and

$$2\pi r_2 N = 2\pi (R + r_2) \quad (2)$$

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Dividing (1) by (2) we obtain:

$$\frac{r_1}{r_2} = \frac{R + r_1}{R + r_2} \qquad (3)$$

This condition of equality can occur only when either $R = 0$ or $r_1 = r_2$. The first is a practical impossibility; the second can be only approached by a good design, fine workmanship, careful selection of materials and their proper treatment. It should be observed that

$$\frac{r_1}{r_2} < 1, \text{ and } \frac{R + r_1}{R + r_2} \text{ is also less than unity.}$$

Applying the same analysis to the inner race we find that for true rolling action

$$\frac{r_1}{r_2} = \frac{R - r_1}{R - r_2} \qquad (4)$$

Since r_1 is less than r_2, we have in practice:

$$\frac{r_1}{r_2} < 1, \text{ but } \frac{R - r_1}{R - r_2} > 1.$$

Thus the greatest amount of sliding occurs on the inner race. In practice r_1 approaches r_2 so closely as to make the amount of sliding almost nil.

Now, to compare the bearings illustrated in Figs. 1 and 2, let us assume workmanship, materials, etc., equally good in both bearings. Then, for the same amount of distortion of the ball the sliding action in Fig. 1 is proportional to $R_1 - R_2$, which is a fairly appreciable quantity, whereas in Fig. 2 it is proportional to $(R + r_2) - (R + r_1)$ or $r_2 - r_1$, which is almost negligible in amount. Thus, so far as sliding action is concerned, the radial type of bearing possesses a great inherent advantage over the cup and cone type, due entirely to the location of the points of contact, whereas a simple geometrical analysis would place the two bearings on a par. There are, of course, other points of difference between the two bearings, but they have nothing to do with either rolling or sliding.

* * *

EXPERIMENTS ON ROPE DRIVING

Very extensive experiments have recently been conducted under the auspices of the Society of German Engineers at the Charlottenburg laboratory. These researches cover a wide field, and of especial interest are those which relate to the influence of velocity. The efficiency in per cent is given under various tensions, showing a considerable decline at low loads. With a tension of 286 pounds in a rope of two-inch diameter, which is somewhat below the tension of 200 pounds per square inch commonly employed in calculations, the efficiency is 98 per cent at 2540 feet per minute and 96 per cent at velocities of 7680 feet per minute. These experiments conform so nearly with discoveries which were made many years ago as to make it fairly certain that with a properly designed installation and with a good grade of cotton rope the high point of efficiency, which by many tables is indicated to be at from 4500 to 4800 feet per minute, may be moved a considerable distance beyond these figures. They also indicate that rope drives can be used to advantage at much higher speeds. Another matter definitely established by the Charlottenburg tests is that idler or jockey pulleys produce a marked loss in efficiency.

The evidence from actual experience, as well as from tests, indicates that it is safe to use proper installations of rope drives up to 7000 feet per minute, and that the power up to this speed will be approximately in direct ratio to the increase in speed. As an example, it may be mentioned that nine ropes of two-inch diameter are regularly conveying a normal load of 880 horsepower at 7200 feet per minute in a large steel works in Germany. This is double the amount allowed by many tables in which too much allowance was made for centrifugal force by the compilers. It therefore would appear that the high speed permissible with rope drives is not limited so much by the rope efficiency and endurance, as by the material in the pulleys being able to resist the centrifugal stresses.

AUTOGENOUS WELDING OR AUTOGENOUS SOLDERING

In a paper read before a recent meeting of the Engineers and Shipbuilders of Scotland Mr. C. B. Desch compared the process of autogenous welding with that of other processes for joining metals. The following paragraphs contain a summary of the remarks made by Mr. Desch. As will be noted, an interesting distinction is made between welding and autogenous soldering, the latter name being preferred by the author of the paper. The term "welding," it was stated, is now somewhat loosely applied. It meant originally the union of two pieces of metal within their plastic range, but below their melting-point, as in an ordinary blacksmith's forge weld. It is now applied, in the term "autogenous welding," to denote a process of union by fusion, either of a part of the metal to be united or of a separate piece of metal used as a solder. Such a process is really autogenous soldering, not welding.

The ideal condition to be reached in a weld is that in which the crystals are continuous from one side of the weld to the other, with no change in the average dimensions of the crystal grains in passing through the weld. This condition requires the complete absence of intervening layers of impurities, especially of oxides, and also the absence of a zone of overheated metal. In true welding, which can take place at as low a temperature as 1450 degrees F., but which, of course, proceeds with much more rapidity and certainty at higher temperatures, there is mutual interpenetration, and, if oxidation is completely prevented, there is no reason why the weld should be weaker than the remainder of the metal. In practice, the weakness so frequently observed is due to incomplete union, readily seen under the microscope. The conditions are somewhat different when any of the high-temperature methods of autogenous soldering are applied. In electric resistance welds, the presence of oxide may be clearly traced along the plane of union, and a zone of very coarse crystallization is obtained.

The process of autogenous soldering with a blow-pipe flame introduces new conditions. Should the flame contain an excess of oxygen, oxide films are produced; with acetylene in excess, a carburized layer may be formed. In either case the joint is bordered by a zone of coarse, over-heated metal. In welding by a carbon arc, local carbonization is still more likely to take place, and the union is often extremely local. There remains the process of thermit welding, in which the two pieces of steel are united by a layer of almost pure molten iron, which alloys perfectly with the adjoining metal. Here, also recrystallization goes on in the immediate neighborhood of the joint, but to a less extent.

The evil effect of overheating may be largely overcome by hammering or forging the weld, followed by a short annealing process. Annealing alone is not usually successful. Imperfect union through the presence of gas cavities or inclusions of slag or oxide, and heterogeneity due to a highly carburized zone, are defects which are not removed by subsequent treatment.

It is not the intention to suggest that autogenous soldering is a process to be condemned. On the contrary, it has a wide field of usefulness, and is, in fact, a necessity for certain classes of work. It must be admitted, however, that a joint made in this way has not the same qualities as the original steel. It is not sufficient to show that fracture does not commonly take place in the plane of union when a mechanical test is made. It is not the weld, but the zone immediately near it, which is injured. Neither are tensile tests conclusive on this point, as the injury to the steel does not always affect the tensile breaking strength, but is revealed when the welded steel is subjected to shock or fatigue. Accounts have been published of boilers which have cracked in places in the course of use, after being repaired by autogenous soldering. When it is intended to use the same pressure as before, and to regard the plates as retaining their original strength, such a practice seems very undesirable. A systematic series of fatigue tests on such repaired plates would be interesting and valuable.

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THE "FIVE BROTHERS"

Typhoid fever increases the weight of a patient, if he recovers from that malady; and a somewhat similar effect may be produced on the business of this country by the flood of legislation which has been recently enacted. A considerable number of these laws are good and should work out beneficially for the country. The trusts and big corporations have been curbed, which most of them needed; but we have reached the time when working people, among whom may be classed a good many machinery manufacturers, are anxious to saw wood again. Probably only a small number of the readers of MACHINERY are familiar with the legislation known as the "Five Brothers," kin in name only to the "Seven Sisters," a series of bills passed by the New Jersey legislature while President Wilson was governor of that state.

Some of the "Five Brothers" will accomplish desired reforms, and others will interfere with legitimate business, including the machinery business; although recent reports from Washington indicate that several objectionable features will be omitted or changed. One, which at this writing still stands, would prevent a manufacturer from giving his exclusive agency to a dealer and protecting that dealer in his territory so that he can educate his men on the mechanical and selling points of a machine and safely assume the expense of working up a sale. Another clause requires a manufacturer to sell his product at the same price (allowing for freight) in all parts of the country, making him liable if a dealer or agent should grant any concession from the price, such as taking a second-hand tool in part payment. A law of this character might be welcomed by manufacturers if they were allowed to make an agreement for the maintenance of prices with each other and with their agents; but such an agreement would throw them into the clutches of the Sherman law, which expressly prohibits it. These provisions were doubtless intended to prevent discrimination against competitors by trusts and powerful combinations, but some other way should be discovered to accomplish this object that will not harass legitimate manufacturers.

* * *

THE SPIRAL BEVEL GEAR

The development of the spiral bevel gear generating machine primarily for automobile manufacture will probably lead to the use of this type of gearing in other machinery. The spiral bevel gear has the same characteristic as the spiral spur gear as regards smoothness of action. The double spiral or herringbone gear is being used extensively now in machine construction, because of its efficiency and noiselessness. Improved machinery that produces this type in one piece has reduced the cost so that its use is feasible where once it was out of the question.

The spiral bevel gear made by the generating process is nearly noiseless, and when designed for drive in one direction only can be made highly efficient. This high efficiency is partly due to the spiral form of tooth, the inward thrust of which balances the outward thrust because of the pressure angle and angle of face.

The spiral bevel gear may be used in preference to ordinary spiral or helical gears for right angle drives, first because the shafts are in the same plane, and second because of the practical absence of thrust. Whether they will show as high efficiency as the best worm-gears of the same velocity ratio remains to be seen, but probably they will. The matter of lubrication is not so important as with worm-gears, and when there is doubt of the ability to lubricate properly, the spiral bevel type will be at a decided advantage.

* * *

THE STATUS OF GEAR GRINDING

The improvements in automobile design and construction have led to demands for gear durability and accuracy far exceeding anything that had been previously required of gear makers. They soon found that gears made by old-time methods from the ordinary grades of steel would not meet the close limits of accuracy and the physical tests imposed. When it was found that gears hardened by the time-honored methods were sprung out of shape, the natural remedy was to grind the teeth after hardening and thus restore them to true shape. Several gear-grinding machines were built and put into use, but with varying degrees of success.

While the grinding of spur gears is being done, the grinding of bevel gears for rear axle drives is now believed to be unnecessary. The improvements made in steel and in the design of bevel ring gears have produced a practically non-changing shape when hardened in machines provided for holding the gears between plates when dipped. The saving of time and labor is so great and the results are so uniformly satisfactory that the grinding of bevel gears has been abandoned by at least one large concern which had designed and built a machine for the purpose at heavy cost.

There is, however, a field for gear-grinding machines of some importance outside of the automobile industry. Cast spur and bevel gears can be made true and smooth by grinding at small cost, and in the case of cast steel gears used on electric railway motors, the cost is well repaid.

* * *

SPECIALIZED MACHINE TOOL BUILDING

The demands of the large automobile builders for special machine tools will apparently have a marked effect on the trend of American machine tool design within the next few years. Machine tools will be graded in three general classes: First, there will be the adaptable machine tool used in jobbing shops for all kinds of repair work and machine building. These tools will comprise the present types of engine lathes, planers, drilling machines, shapers, milling machines, gear-cutting machines, grinding machines and slotting machines. Second, there will be the more specialized machines, adaptable, it is true, but better suited for manufacturing than jobbing work which may give a dozen different kinds of work to a machine in a week. These machines will comprise the automatic screw machines, semi-automatic chucking lathes, automatic gear-cutters, bevel gear generators, hobbing machines, multiple-spindle drilling machines and broaching machines. Third, there will be purely specialized machines designed and built solely for the rapid production of machine parts of a given size, shape and material. These machines will be built around the past, as it were. The designer will study the part, and design a machine to produce it at the least possible cost of time and labor. Drilling machines that drill forty or fifty holes in four motor cylinders *en bloc* in several directions simultaneously are examples.

ETHICS OF CONTRIBUTING

The position of the editor of a technical journal like MACHINERY as regards publicity of methods, tools and processes is difficult to fill with satisfaction to all classes of readers. The ambitious mechanic wants to learn all about the methods and tools used in the most up-to-date manufacturing plants. The manufacturers, on the other hand, in some cases believe that it is distinctly to their disadvantage to have descriptions of up-to-date methods published. To steer a course that will avoid the objections of the manufacturers on the one hand without disregarding the wants of the ambitious readers on the other, is not always easy.

A letter was recently received from a prominent manufacturer referring to a contribution describing an improved trimming and shaving die. This contribution appeared to the editor to be only one of many good articles published describing improved punch and die equipment, but to the manufacturer whose practice was shown, the publication was a serious, if not a vital matter. He wrote as follows:

We call your attention to an article by —— ————. This man was formerly employed by us as a toolmaker and had nothing whatever to do with designing the dies which he described. On the contrary, he simply worked to drawings made by our designers, and under the supervision of experts in our tool department. You will therefore understand how this article has been published without our consent, and that the drawings, which are the property of this company, have without doubt been copied and carried away by the writer of the article. You are doubtless aware of the fact that manufacturing methods and the designs of tools and fixtures are very often the result of long study and particular investigation, involving a large expenditure of time and money, and that information of this character must therefore be considered as a valuable asset and as such be carefully guarded and given out only through the proper channels. While we do not wish to imply that you would publish articles of this character were you aware of all the facts, nevertheless, you must agree with us that great injustice might be done to the rightful owners of designs, tools and fixtures if they were given publicity through the medium of trade journals. To our minds this raises a serious question and we shall be pleased to have you advise us whether you do not feel that careful inquiry should be made when an article is offered to you for publication to determine whether your correspondent has a right to use the information which forms the subject of the article.

To one familiar with the editing and publication of a technical journal it would be obviously impracticable for the editor to inquire closely into the antecedents of all contributors and contributions. We must rely on the honesty and good intentions of our contributors in general. MACHINERY is not a market for "stolen goods"; and most, if not all, contributors realize it. But what constitutes stolen goods in toolmaking practice? A toolmaker surely has the right to carry away with him from any plant where he has been employed good ideas in toolmaking, etc. His new employers have a right to expect that years of experience have given him knowledge of the best practice. How is it better for such a toolmaker to give to a competitor the best ideas he has gleaned from his experience than to publish them in a trade journal? In the case under discussion, the contributor probably did not consider that the design was in any sense proprietary, but only a development of punch and die practice right up to the minute. A history of this particular tool would undoubtedly show that hundreds of workmen and various plants had contributed ideas and resources which made its ultimate development possible. This seems to us to be a case where the editor must absolutely depend on the good faith of the contributor for the proper protection of "vested rights."

* * *

The Supreme Court handed down a decision February 27, giving the Wright Co. the exclusive control of ailerons or wing warping devices for aeroplanes. This decision apparently means that the company will absolutely control the aviation field and that none of the builders of heavier-than-air machines can build machines hereafter without a license from the Wright Co. The Wright Co. plans to collect royalties amounting to $1000 for each machine, taxing each machine about twenty per cent of its cost.

BEARING PRESSURES DUE TO THE ACTION OF BEVEL GEARS UNDER LOAD

BY RALPH E. FLANDERS*

The action of a pair of bevel gears under load produces a radial pressure on the bearings due to the tendency of the driver to climb onto the driven gear. The pressure angle of the involute teeth also produces a force tending to push the gears out of engagement. This angular thrust may be resolved into a radial bearing pressure and a direct end thrust on the shaft. The amount of radial bearing pressure and end thrust due to a given load on a given gear may be calculated by rules and formulas presented herewith. We must have the following data: The pitch diameter, with width of face, and the edge angle of the gear, which is the same as the pitch cone angle. These dimensions are shown in Fig. 1. It is also necessary to know the horsepower and revolutions per minute, or the torque in inch-pounds to which the gear will be subjected. The pressure angle of the teeth, *i. e.*, whether they are 14½ degree standard teeth, or whether they are 20 degree or other shape, must be known. It makes no difference whether the teeth are of standard length or of the "stub tooth" variety.

We will evidently get different driving pressures on the teeth, depending on whether we use the pitch diameter at the

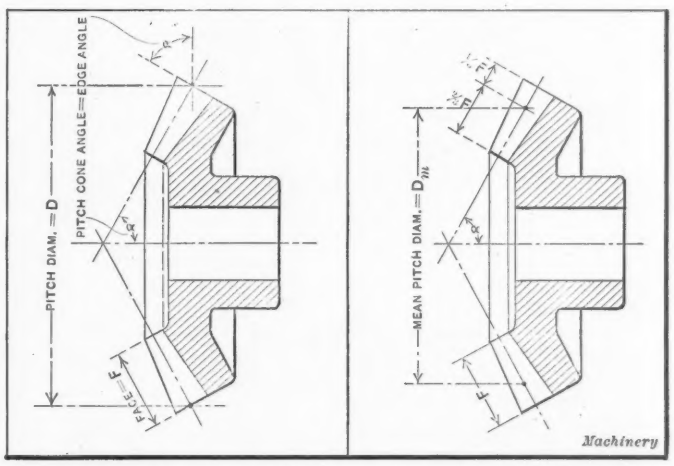

Fig. 1. Gear Dimensions required to determine Radial Pressure and End Thrust

Fig. 2. Mean Pitch Diameter defined for Purposes of Calculation

large end or at the small end of the teeth for cur calculations. We should evidently use a diameter somewhere between to get correct results. An accurate calculation would require consideration of the elasticity of the tooth, which would be somewhat complicated. It will be well enough to locate our mean pitch circle at one-third the width of face from the large end of the tooth. The diameter thus located, as shown in Fig. 2, may be considered the mean pitch diameter for the purposes of this calculation. This mean pitch diameter may be obtained either by measuring an accurate drawing or by the following calculation:

RULE 1. *To find the mean pitch diameter multiply two-thirds the width of face by the sine of the edge angle, and subtract the product from the pitch diameter.*

RULE 2. *To find the tangential tooth pressure (which equals the direct radial pressure on the bearing) divide the torque in inch-pounds by one-half the mean pitch diameter.*

RULE 3. *The result obtained by* RULE 2 *can also be obtained by multiplying the horsepower transmitted by 126,050, and dividing by the product of the revolutions per minute and the mean pitch diameter.*

The next step is to find the thrust, due to the tooth pressure and the angularity of the gear, in the direction *x–x* in Fig. 3. This may be done by the regular parallelogram of forces or by calculation as follows:

RULE 4. *To find the angular thrust of the gear, multiply the tangential tooth pressure by the tangent of the pressure angle of the tooth.* (Note: For a 14½-degree tooth the tangent is 0.2586; for 15 degrees, 0.2680; for 20 degrees, 0.3640; for 22½ degrees 0.4142.)

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This angular thrust, as shown in Fig. 3, may be resolved into two components: one, the direct thrust on the shaft (which may be taken care of by a thrust bearing); and the other, an additional radial pressure on the bearing. These quantities may be derived by the parallelogram of forces or by the following calculation:

RULE 5. *To find the direct thrust on the shaft, multiply the angular thrust by the sine of the edge angle.*

RULE 6. *To find the additional bearing pressure due to the angular thrust, multiply the angular thrust by the cosine of the edge angle.*

It is evident from Fig. 4 that the bearing pressure due to the angularity of the teeth is at right angles to that due to the tangential tooth pressure carrying the load. The resultant total pressure on the bearings may be obtained by the parallelogram of forces or by calculation as follows:

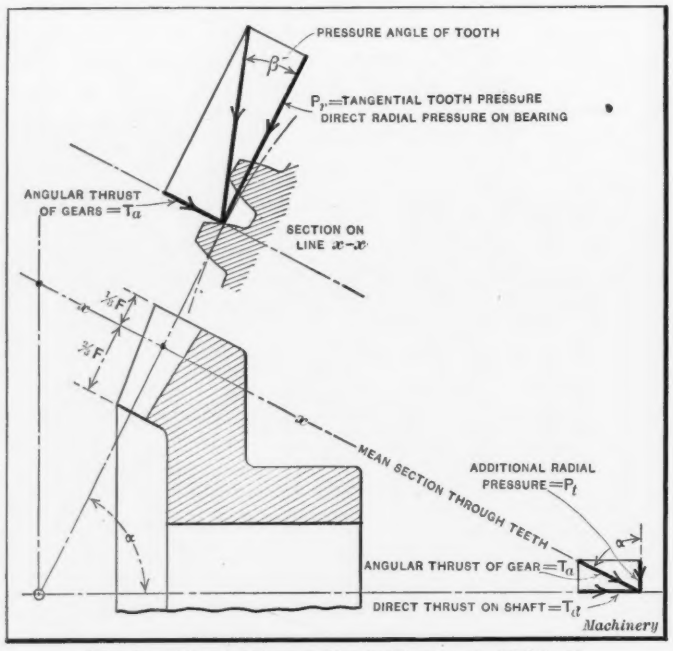


Fig. 3. Determination of Direct Thrust and Additional Radial Bearing Pressure

RULE 7. *To find the total radial pressure on the bearings, add the squares of the tangential tooth pressure and the additional radial thrust on the bearing due to the angular thrust, and extract the square root.*

The foregoing rules may be expressed in the formulas:

$$D_m = D - 2/3\,F \times \sin a \quad (1)$$

$$P_r = \frac{2\,M}{D_m} \quad (2)$$

$$P_r = \frac{126{,}050\,H}{R\,D_m} \quad (3)$$

$$T_a = P_r \times \tan \beta \quad (4)$$

$$T_d = T_a \times \sin a \quad (5)$$

$$P_t = T_a \times \cos a \quad (6)$$

$$P_b = \sqrt{P_r^2 + P_t^2} \quad (7)$$

in which

D = pitch diameter;
F = width of face;
a = edge angle (same as pitch cone angle);
D_m = mean pitch diameter;
M = torque or turning moment in inch-pounds;
H = horsepower transmitted;
R = revolutions per minute;
P_r = radial bearing pressure = tangential tooth pressure;
β = pressure angle of involute tooth;
T_a = angular thrust of gears;
T_d = direct thrust on shaft due to angular thrust of gears;
P_t = additional radial pressure on bearings due to angular thrust;
P_b = total radial pressure on bearings.

As an example, take the case of the gear shown in Figs. 3 and 4, whose dimensions are as follows: pitch diameter = 6 inches; face = 1⅛ inch; edge angle = 63 degrees 26 minutes; horsepower = 19 or torque = 1500 inch-pounds; pressure angle of tooth = 20 degrees. The radial pressure and thrust on the bearing are found by calculation from the above rules and formulas, as shown below. Graphical calculations giving the same results by the parallelogram of forces are indicated in Figs. 3 and 4.

$$D_m = 6 - \tfrac{3}{4} \times 0.8940 = 5.330 \text{ inches.} \quad (1)$$

$$P_r = \frac{3000}{5.33} = 562 \text{ pounds.} \quad (2)$$

$$P_r = \frac{126{,}050 \times 19}{800 \times 5.33} = 560 \text{ pounds (approximately).} \quad (3)$$

$$T_a = 560 \times 0.3640 = 204 \text{ pounds.} \quad (4)$$

$$T_d = 204 \times 0.8940 = 182 \text{ pounds.} \quad (5)$$

$$P_t = 204 \times 0.4470 = 91 \text{ pounds.} \quad (6)$$

$$P_b = \sqrt{560^2 + 91^2} = 567 \text{ pounds.} \quad (7)$$

It will be seen from calculation No. 7 that the pressure angle of the tooth has a practically negligible effect in increasing the radial bearing pressure. In the case of spur gears, this effect is so small that the angular pressure need not be reckoned with; and in bevel gears the effect is even smaller, since a good share of the angular pressure is transmitted into thrust. It is, therefore, not necessary in practice to carry the calculations beyond the fifth rule or formula. The total radial bearing pressure thus found is, of course, distributed between the bearings of the shaft, usually two in number, in accordance with the principle of moments (see MACHINERY'S Handbook, pages 338 and 339). The pressure on each bearing resulting from the gear action, as previously calculated, must be combined by the parallelogram of forces in the same way as shown in Fig. 4 with any other pressures arising in these bearings from other gears, belts, pulleys, brakes, or similar loads on the same shaft.

* * *

The first mention of platinum by name was made by Antonio de Ulloa in 1748. The great Ural fields of platinum were discovered in 1803 and then platinum became recognized as a metal of interest and use. Since then the interest and use have been increased by leaps and bounds so that within the last five years the price has increased from $20 to $46 per ounce. The United States now imports $4,000,000 or $5,000,000 worth a year. Platinum is an extremely useful

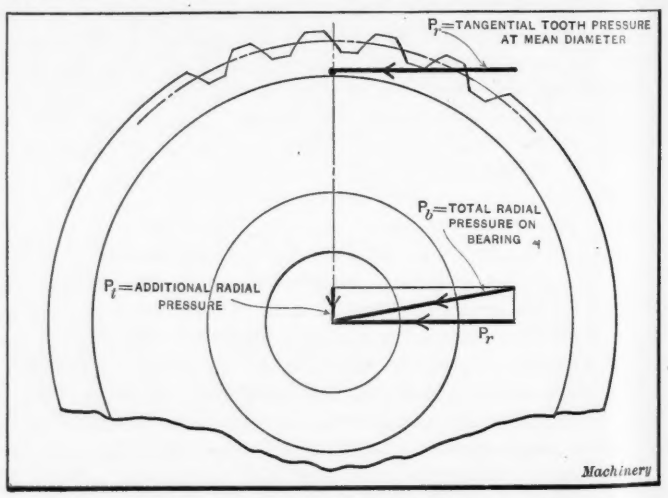


Fig. 4. Determination of Total Radial Pressure on Bearing

metal in the arts and chemists would be helpless without it. Liebig said, not many years ago, that without platinum the composition of most minerals would have remained unknown because the acids that will dissolve the minerals will also dissolve glass or porcelain and the heat required would melt gold or silver. Platinum is melted in a lime crucible, using an oxy-hydrogen blow-pipe. Its specific gravity varies. The higher the specific gravity, the more lasting the polish. Ordinary re-melted platinum has a specific gravity of about 20.3 and a cubic inch weighs 0.72 pound, but the best platinum has a density of 22.669 and the weight of a cubic inch is 0.798 or approximately four-fifths of a pound. Platinum is hardened with iridium, but as iridium costs nearly double as much as platinum, or $85 per ounce, it is used sparingly.

MAKING SPITZER BULLETS*

MACHINES, DIES, TOOLS AND METHODS USED BY THE FRANKFORD ARSENAL

BY DOUGLAS T. HAMILTON†

The methods used in the manufacture of Spitzer bullets for 0.30 caliber cartridges are of an unusually interesting nature. The point of the bullet must be absolutely concentric with the body if good results are to be obtained. If the point is slightly eccentric, the bullet is erratic in its flight and cannot be depended upon to shoot accurately. It is therefore not only necessary to exercise the greatest care in the final operations on the bullet, but the same exactness and careful attention must be followed from the initial operation through to the finished product. The cup, in fact, has to be started just right. The walls must be of equal thickness and drawn straight, as any difference in the length of the cup means, as a rule, a variation in the thickness of the wall. This variation in the thickness of the wall will be apparent in the finished shell and is somewhat exaggerated in each successive operation, so that the care that must be exercised in drawing makes this work rather unusual in its character.

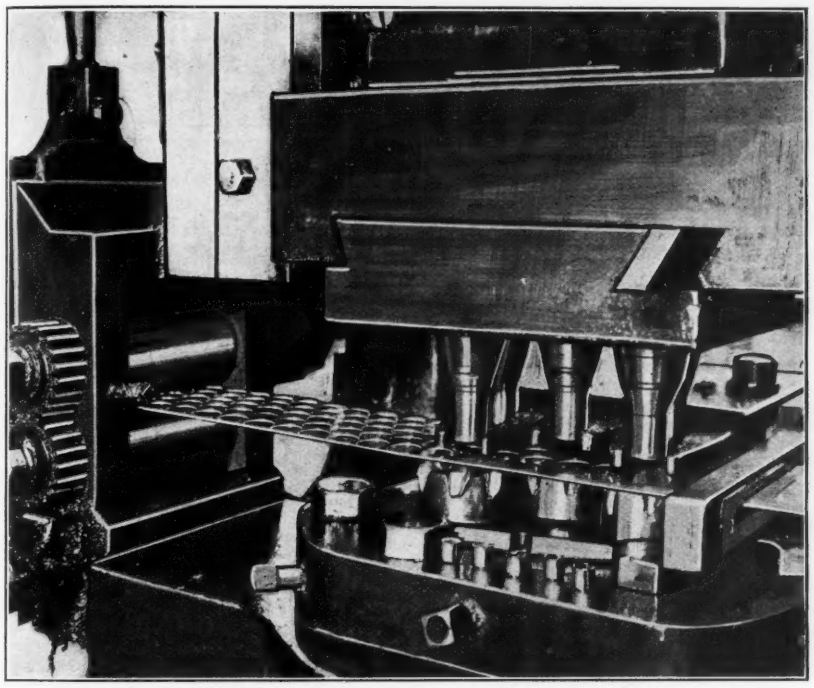


Fig. 1. Blanking, cupping and drawing the Nickel Case for Spitzer Bullets at the Rate of 470 per Minute, using Five Combination Punches and Dies

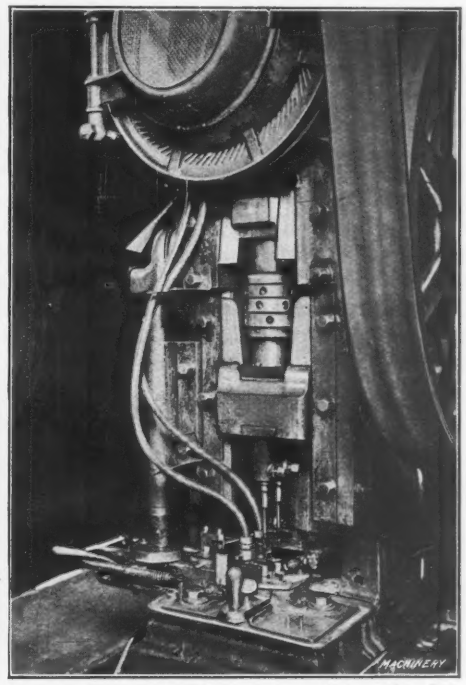


Fig. 2. Type of Drawing Press used for redrawing Nickel Jacket Cases for Spitzer Bullets using Two Punches and Dies

Making Cups for Spitzer Bullets

The cups from which Spitzer bullet cases are made are produced from stock composed of 85 per cent copper and 15 per cent nickel. This material is purchased in sheet form and comes in rolls about 12 or 14 inches in diameter. In operation, the roll is held on a stand, as was described in connection with the making of the brass cartridge case in the March number, and is fed into a double-action press. When making the cups for the Spitzer bullet, five combination punches and dies, as shown in Fig. 1, are used. These are of the same shape and type as those shown in Fig. 10 of the article referred to, and the press is operated at a speed of ninety-four revolutions per minute, giving a production of 470 cups in this time. In addition to blanking out and cupping, this machine also performs the first drawing operation on the nickel cup. Before any further operations are performed, the cups are annealed, washed and dried and are then ready for the redrawing operation.

Redrawing Nickel Jacket Cases for Spitzer Bullets

The redrawing operations on the nickel jacket cases for Spitzer bullets are accomplished in a drawing press of the type shown in Fig. 2. This machine carries two punches and two dies as illustrated. The punches are carried in a head operated by a crankshaft, and the feeding mechanism is actuated by a cam, receiving power from the crankshaft through a pair of bevel gears and the vertical shaft shown. The cups are placed in a hopper located at the top of the machine in which a wheel carrying pins rotates. These pins pick up the cups and carry them to a receiving chute, from which they pass down through brass tubes made from close-wound brass springs, which carry the cups down to the feeding mechanism of the machine. The feeding mechanism consists of a slide in which fingers are held that grip the cups and carry them forward to the punches, which as the ram descends force the cups out of the fingers and through the redrawing dies. There are three redrawing operations on the nickel jacket case as shown by *A*, *B* and *C* in Fig. 3; this illustration also presents the three redrawing punches and dies used. The redrawing operations are accomplished in a press of the type shown in Fig. 2, which operates at 112 strokes per minute and turns out 224 cups in this time.

Making Lead Fillings or Slugs for Spitzer Bullets

The lead fillings or slugs for Spitzer bullets are made from wire which is produced in the hydraulic press shown in Fig. 4. This lead wire is made from large billets of a composition metal consisting of 30 parts lead and 1 part tin. A group of these billets just as they come from the mold may be seen in the foreground of the illustration. These are cast in an iron mold and are 4¾ inches in diameter by 13¾ inches long. The machine in which the billets are placed is operated on the hydraulic principle, water being used as a medium for obtaining the desired pressure, and is capable of exerting a pressure of 1000 tons per square inch.

In operating this machine the lead billet is placed on the stand *A*, and as the plunger of the machine ascends after forcing out the metal, this stand also rises until the billet comes almost level with the chute *B*. The operator then disaligns the plunger, as will be described later, dumps the lead billet off the chute, dropping it down into the die of the machine, aligns the plunger, starts up the machine, and as the plunger again descends, it forces the metal out through sizing dies. The metal, in passing out from the large die or billet container of the machine, passes through sizing dies

* For additional information on cartridge making, see "Drawing Cartridge Cases" in the March, 1914, number of MACHINERY and articles there referred to.

† Associate Editor of MACHINERY.

which form the wire to the correct diameter, in this case, 0.380 inch. When the machine first starts to force the lead wire out, the gage indicates a pressure of 600 tons, which gradually drops down to 550 tons as the metal begins to heat up and become softer.

As the lead wire is squirted out of the dies, it passes over a roll *C* and thence through a box *D* filled with constantly running water. This serves to cool the wire and harden it to some extent. From the box of water the wire passes over another roll and up through an adjustable mechanism which is used for winding the wire on the spool *E*. The mechanism for locating the wire on the spool is controlled by a double-pitch worm cut right- and left-hand which guides the arm of the feeding or winding attachment. As the wire in being wound up travels over to one side of the spool, the direction of the feeding or winding arm is changed by a dog which throws the nut into the groove in the worm running in the opposite direction. The worm is driven by gears from the pulley *F*, and the spool is driven from the same pulley through a friction clutch.

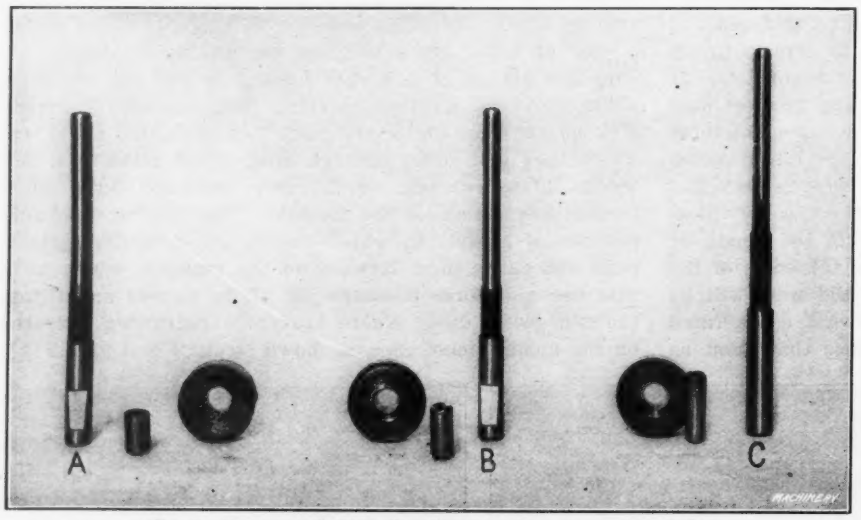


Fig. 3. Sequence of Three Drawing Operations for Nickel Jacket Case for Spitzer Bullets; also Dies and Punches used

To insert the lead billet in the central die of the machine it is necessary to throw the punch out of line with the die so that the billet can enter. This is done in order to decrease the amount of punch travel that would otherwise be necessary, and allows the machine to be operated much more quickly. The mechanism for disaligning the punch is of very simple construction, but is fool-proof. The plunger *G* is thrown out of line by operating the handle *H* and is brought back into line by operating the handle *I*. By looking carefully at this illustration, it will be seen that handle *I* is connected with the mechanism operating the valve of the hydraulic pump, and hence it is impossible to start the plunger on its downward stroke until it is in perfect alignment with the die. This attachment prevents any accident which might happen should the operator fail to align the punch accurately with the die and then start the machine.

Swaging Lead Slugs for Spitzer Bullets

The lead wire produced in the hydraulic machine shown in Fig. 4, after it has been wound on the spool, is taken to the swaging machine shown in Fig. 5, the spool being placed on a stand as illustrated at *A*. The wire passes from this roll down over a number of other small guiding rolls and is forced up by a feeding device located under the machine. This feeding device lifts the wire at each stroke an amount sufficient to produce two slugs. The machine is provided with two dials *B* and *C*, one over the other. The dies in these dials are not used for forming the slugs, of course, but merely act as feeding, or in other words, carrying members. One die in each of the dials *B* and *C* is successively in perfect alignment with the corresponding one in the other dial when the machine is indexing properly. The top dial, which is geared to the lower one, is one-half the size and carries one-half as many dies as the lower one. The lower dial indexes two positions for one index of the upper dial, the latter serving to feed each second successive hole in the lower dial.

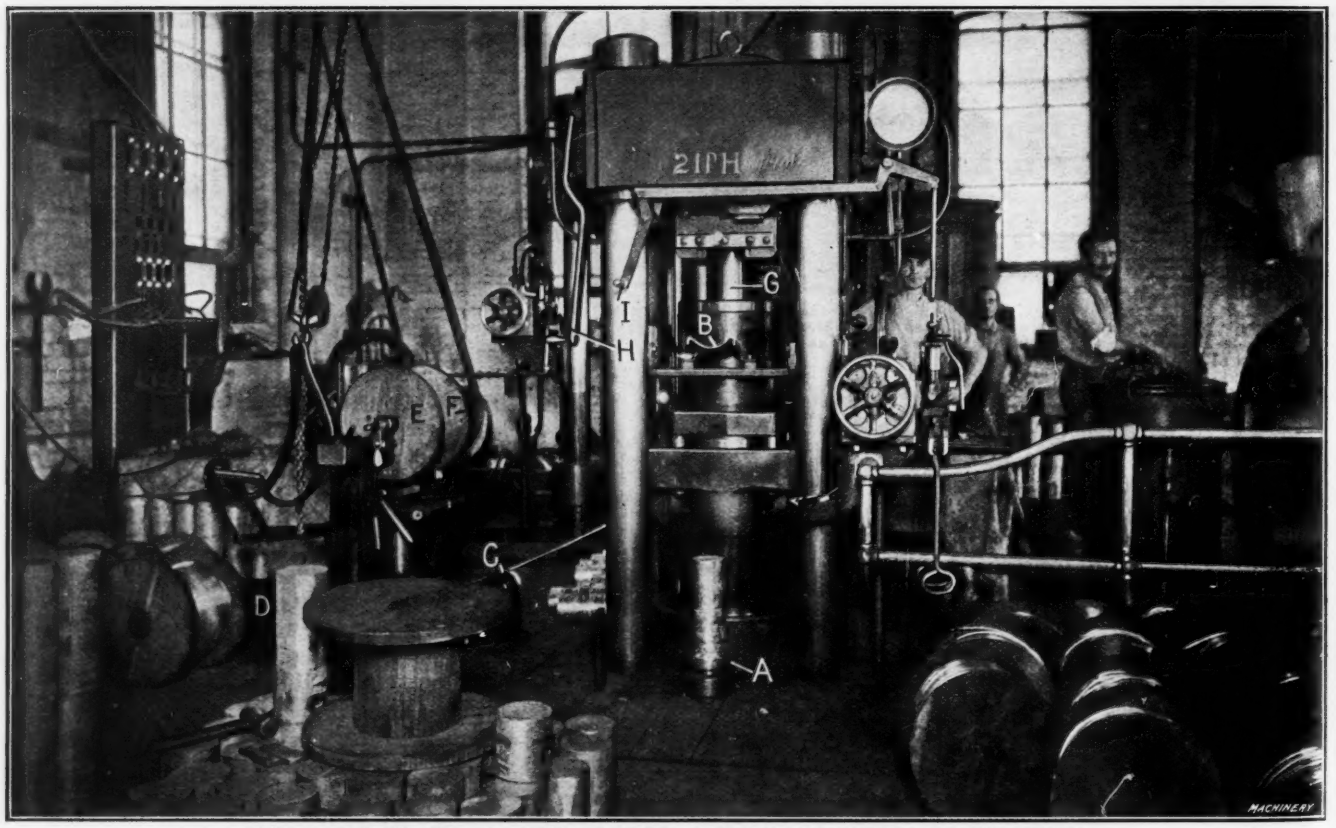


Fig. 4. Hydraulic Press for making Lead Wire, which is used as Filling for Spitzer Bullets

The lower dial, which makes two indexes for every one made by the upper dial, is used for carrying the slugs to the various punches and dies that are used for forming them to the proper shape. There are two sets of punches and dies; the first two punches *D* are used for forming the slugs, the second punches *E* force the formed slug out of the dies,

while the two punches *F* are used as a means of safety. The punch *G* is attached to the knock-off and stops the machine should the wire be feeding short. The last punch *H* knocks out any scrap that may remain in the top dial, and keeps the dies clear. The dies held in the lower dial are used in conjunction with bushings in the machine for cutting off the wire as it is fed up; then the amount of wire fed at each stroke is again subdivided by the dies held in the top and lower dial that work against each other as they rotate. This machine works entirely automatically and when properly set up produces slugs at a rapid rate.

Finish-forming Spitzer Bullets

The most difficult operation in the production of Spitzer bullets is finish-forming them, which consists in pointing the nickel case and making the point absolutely concentric with the body. The type of machine used for this purpose is shown in Fig. 6, where the sequence of operations on the bullet is

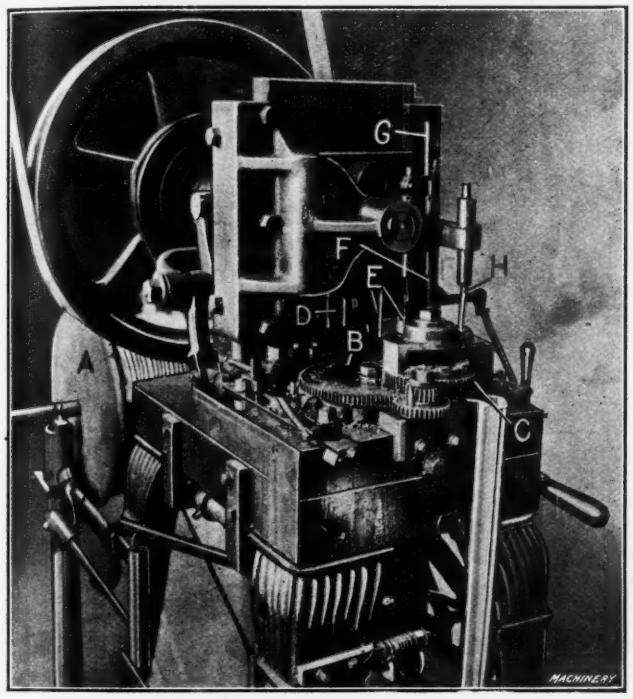


Fig. 5. Swaging Press used for making Lead Fillings for Spitzer Bullets

clearly shown by the samples on the dial. This machine is of the ratchet dial feed type. The nickel cases are located in bushings held in the dial *A* by the operator and are carried around by this medium. The slugs which are held in a hopper at the back of the machine are fed down to the second dial *B*, through a close-wound spring tube. Dial *B* is indexed in a similar manner and in unison with dial *A* and the slugs which are carried in it are forced out and located in the nickel case in the lower dial by means of punch *C* held in the ram of the machine.

Fig. 7 shows the sequence of operations followed in the production of the Spitzer bullet, and also the dies, punches and knock-out pins used. The dies in this case have been sectioned so that their shape can be clearly seen. Fig. 8 shows diagrammatically the operations performed on the

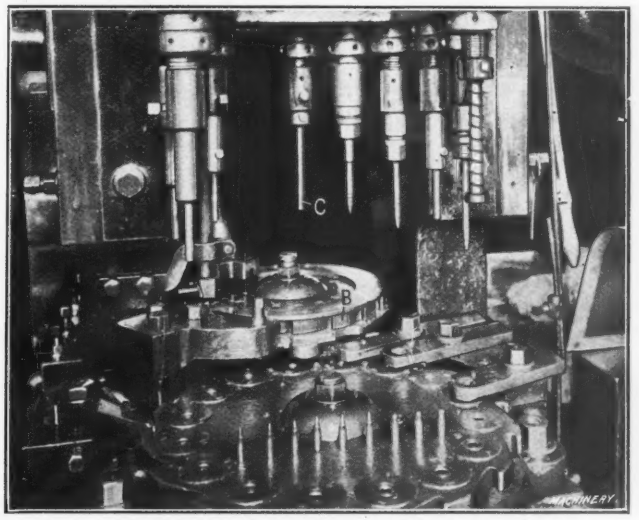


Fig. 6. Machine used for forming the Nickel Cases of Spitzer Bullets and assembling the Lead Fillings in them

Spitzer bullet. Here the relations of the forming punches and knock-out pins to the dies are clearly illustrated. By referring to this illustration, the sequence of operations on the Spitzer bullet will be clearly understood. At *A* the shell is partly reduced in diameter at the point. At *B* the point of the shell is still further reduced and the rounding of the body is commenced. At *C* this operation is carried still further, while at *D* the case is completely formed. In all the operations up to this point, the shell is formed to the shape shown by the punch and die working in conjunction with each other; that is to say, the punch is the same shape as the die, but is smaller in diameter an amount equal to twice the thickness of the walls of the case. At *D* the punch is relieved and only fits the case at the lower or curved portion; however, it follows the case right to the point and is used in connection with the die for forming the point concentric with the body.

At *E* the lead slug is inserted in the nickel jacket case, and it will be noted that the punch cannot pass down into

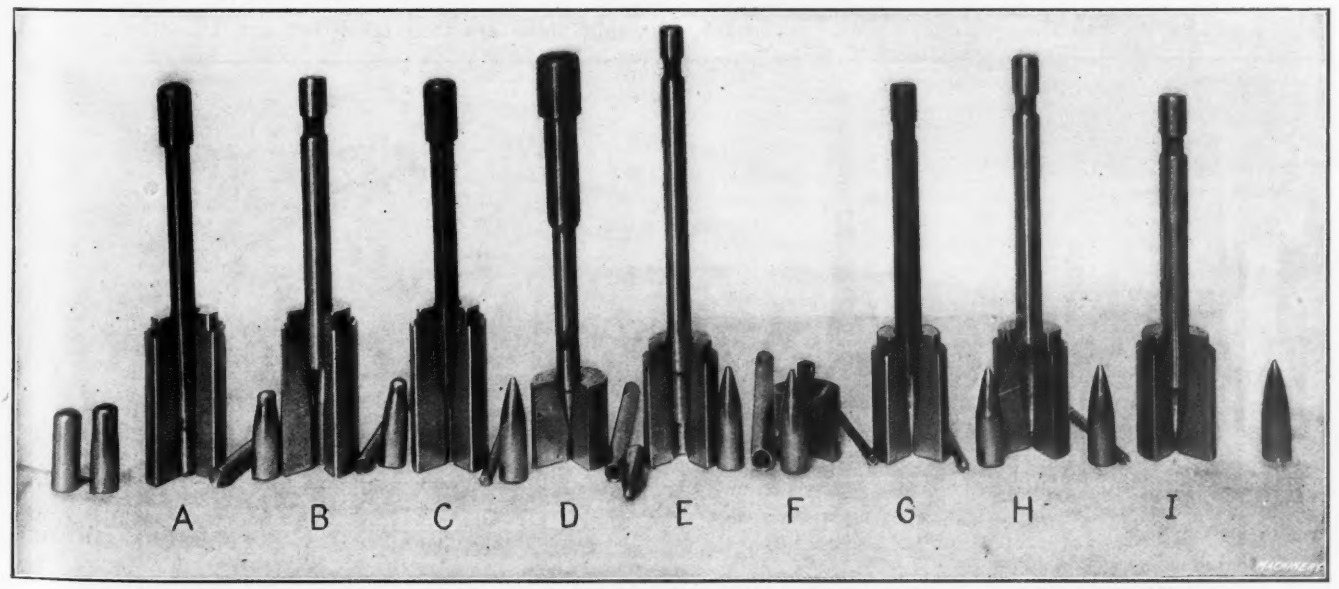


Fig. 7. Illustration showing the Type of Dies and Tools used in the Machine shown in Fig. 6 for making Spitzer Bullets

the shell, but merely rests on top of the lead slug. At *F* the operation accomplished is known as "coning." This is one of the most important operations, as it is intended to make the point of the bullet perfectly concentric with the

body. The die *a* which is used for this purpose only forms the extreme point of the bullet, and does not bear at all on the curved part of the body. These pointing dies are only allowed 0.002 inch float in the holder and must be perfectly in line with the punches. The punches and dies shown from *G* to *I* are used for forming the base of the bullet. These operations consist in turning over the top edge of the nickel case and flattening it down on the lead slug—*J* and *K* show the condition of the nickel case before and after pointing, whereas *L* shows the lead slug and *M* the finished bullet.

The proper setting up of the machine shown in Fig. 6 is an operation that requires some skill. The punches which are held in the ram of the machine must be in absolute alignment with the dies. The pointing dies are only allowed 0.002 inch float in the holders in which they are retained and are set as exact as it is possible to get them. After the machine has been set up, a number of trial bullets are run through; these are then taken out and tested in a special type of high-speed lathe in which the bullet is held true. When put under this test the point of the bullet must run perfectly concentric with the body before the machine can be started on a "run." This test of the bullet is also made

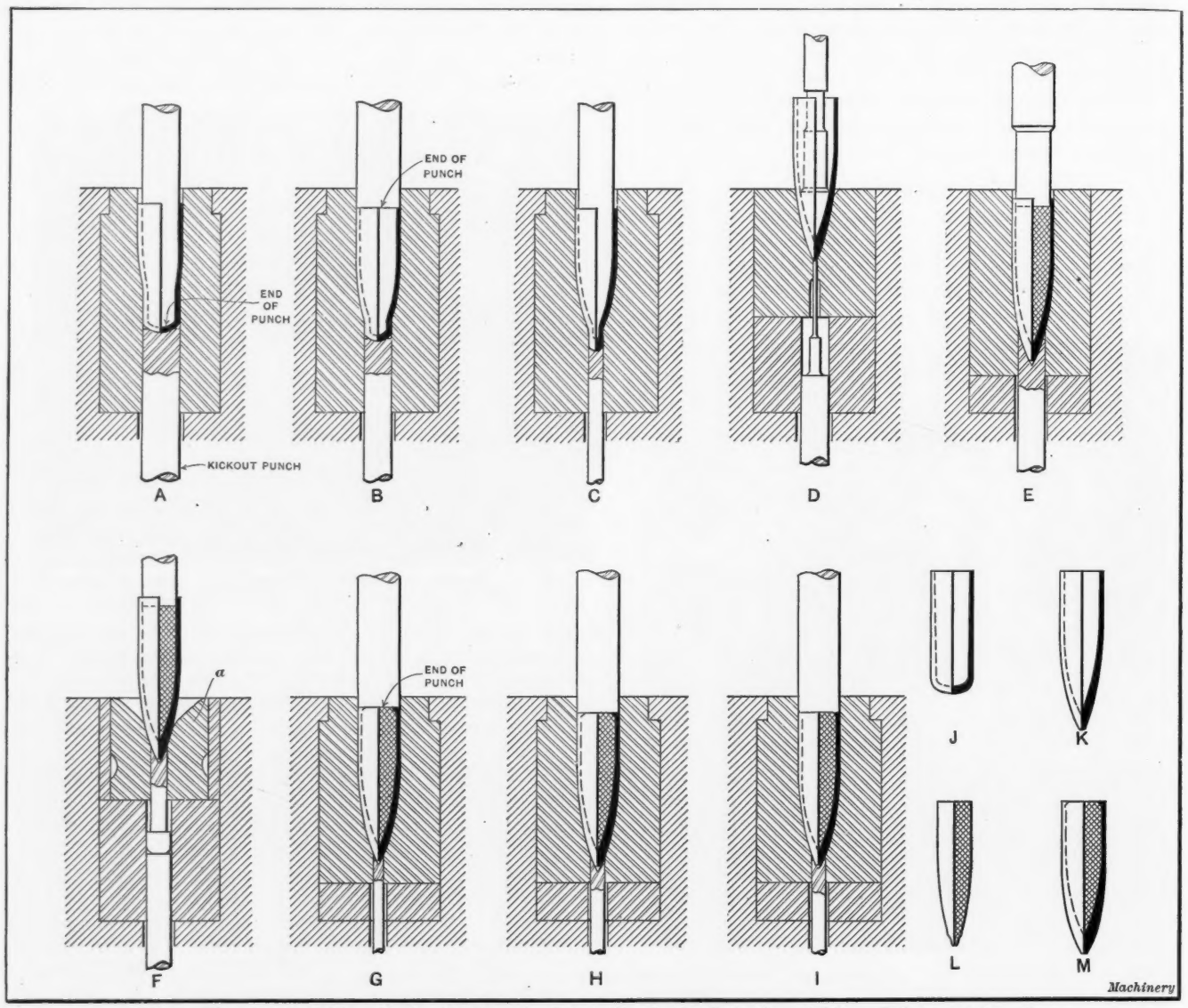


Fig. 8. Diagrammatical View showing the Sequence of Operations in the Production of Spitzer Bullets, and how the Various Tools act in Relation to each other

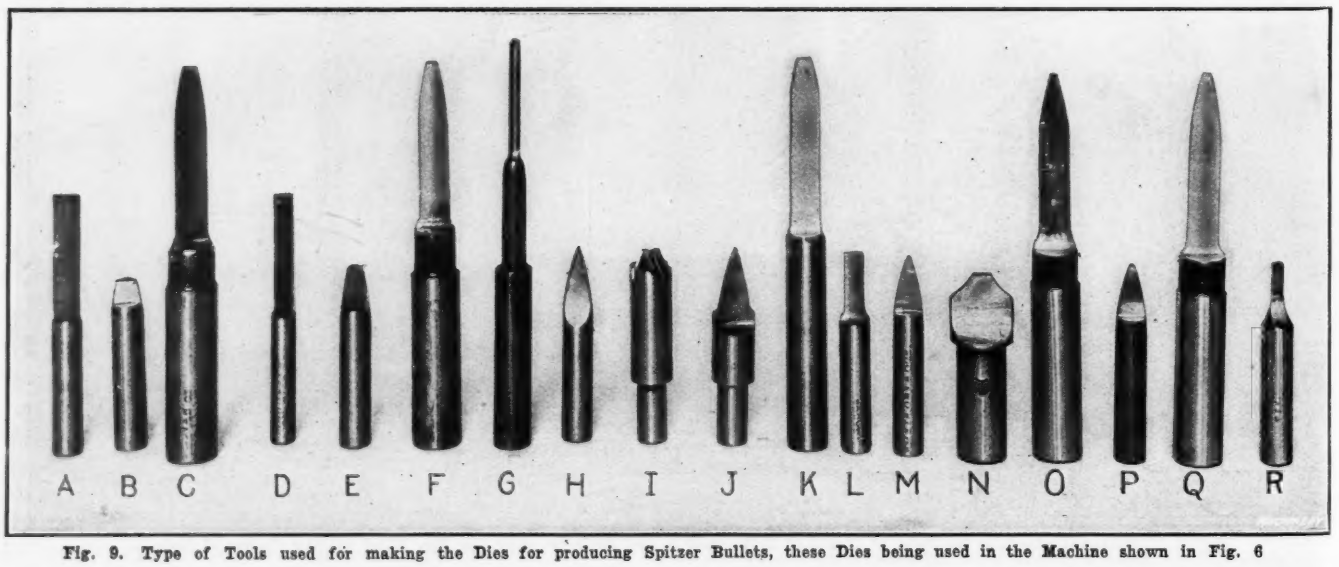


Fig. 9. Type of Tools used for making the Dies for producing Spitzer Bullets, these Dies being used in the Machine shown in Fig. 6

from time to time so that any variation in the setting of the dies will be detected before many scrap bullets have been run through. The making of the dies for bullets of the Spitzer type is considered by cartridge makers to be one of the most difficult propositions in cartridge making. It requires the most excellent tool work and also special care in using the tools, setting them up in the machine and keeping the machine in absolute alignment and perfect running order.

Canneluring and Sizing Spitzer Bullets

In order to provide a means for holding the Spitzer bullet in its proper position in the cartridge case, the bullet is provided with a knurled groove around its periphery near

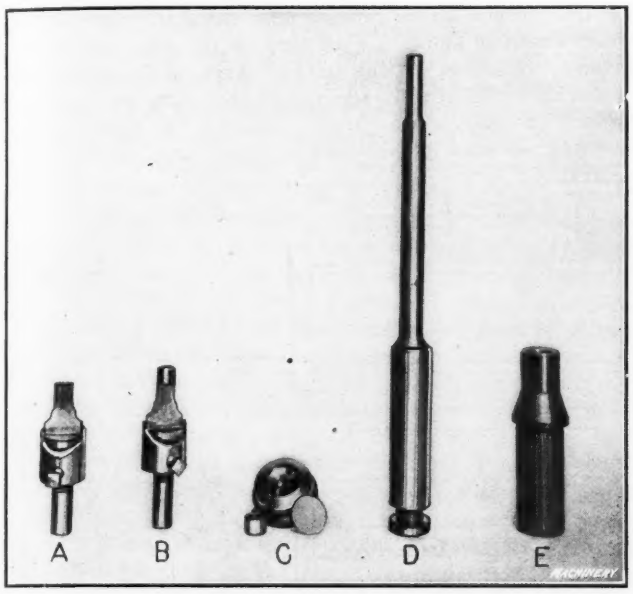


Fig. 10. Combination Blanking Punches and Dies used for making the Nickel Jacket Cups and Tools used for making the Die

the base. This operation is known as canneluring, and is accomplished in the machine shown in Fig. 12. The bullets are dumped into the hopper *A* from which they are conveyed by means of a tapered conveyor screw *B*. Conveyor *B* is rotated by means of a belt *C* running over the pulleys illustrated. The conveyor carries the bullets up to the entrance of the chute *D* which is a close-wound spring, connected with the small hopper forming an auxiliary to the six-hole turret *E* located above the canneluring dial *F*. Turret *E* in which the bullets are dropped rotates and carries the bullets around so that they can be inserted in the dial *F* by means of punches. Dial *F* is also rotated and carries the bullets past

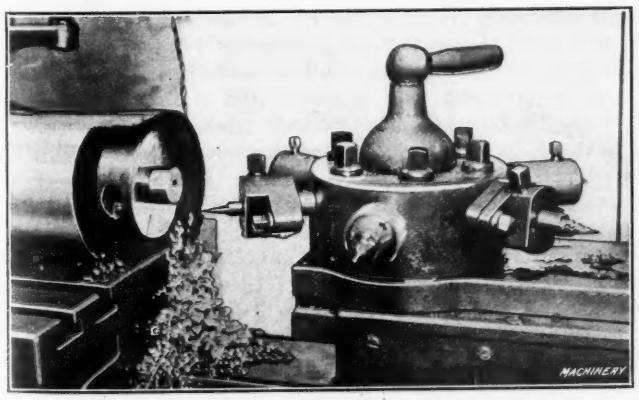


Fig. 11. Making the Pointing Die for a Spitzer Bullet in a Hand Screw Machine

a knurling segment, which produces the small groove in the circumference. As the bullets are cannelured they are forced out of the top dial *F*, pass down through a tube and are located in the lower dial *G*. This lower dial carries the sizing dies, which resize the bullets, this operation being necessary owing to the slight distortion produced during the canneluring operation. The punches for forcing the bullets through the dies held in dial *G* are carried in the slide *H* which is operated by crankshafts *I*. The dial *G* is rotated by a ratchet mechanism receiving power from a fulcrumed lever *J* which carries a roll working in and receiving motion from a groove in cam *K*.

Making Combination Blanking, Cupping and Drawing Dies for Spitzer Bullets

The type of tools used for making combination blanking, cupping and drawing dies for Spitzer bullets is shown in Fig. 10. These tools are of a similar type to those illustrated in a former article. Here *C* is the combination blanking, cupping and drawing die, *E* the blanking punch, and *D* the combination cupping and drawing punch, while *A* and *B* are the roughing and the finishing reamers, respectively, for the die. The information given in regard to the dies for making the brass case also applies to these dies.

Tools used for Making Pointing Dies for Spitzer Bullets

Fig. 11 shows how the pointing dies for Spitzer bullets are made. Sanderson hammered steel is used for making these dies because of its "shock resistance" and also the great hardness that can be obtained without danger of cracking or breaking. The operations in the making of this die which are shown at *D*, Figs. 7 and 8, are as follows: Drill large portion of hole; drill small portion of hole with a No. 68 drill, and insert roughing and finishing pointing reamers.

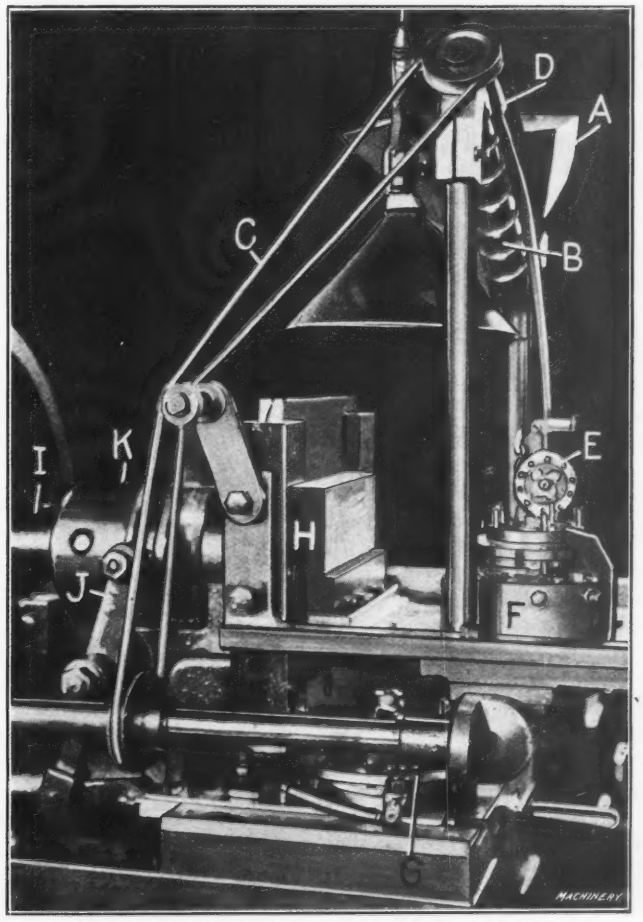


Fig. 12. Machine used for canneluring Spitzer Bullets; also for sizing them

The making of this die represents an excellent example of tool work, as the holes must be in absolute alignment with each other, and the entire curved portion of the hole perfectly concentric throughout.

Fig. 9 shows all the reamers that are used for making the pointing dies shown in Figs. 7 and 8. The names of these are as follows: *A* is the reamer for the first die; *B* is the first and second operation stem reamer; *C* is the reamer for the first and second die shown at *A* and *B* in Fig. 7; *D* is the second operation die reamer; *E* is the second operation stem reamer; *F* is the third operation die reamer; *G* is the reamer for the small hole in the third operation die; *H* is the first pointing die reamer; *I* is the countersink for the mouth of the pointing die; *J* is the pointing die finishing reamer; *K* is the "slug die" reamer; *L* is the slug die stem reamer; *M* is the coning die stem reamer; *N* is the coning die reamer; *O* is the hump die reamer; *P* is the hump and base

stem reamer; *Q* is the base die reamer; and *R* is the base die stem reamer. It will be noticed by referring to this illustration that practically all the reamers are of the "spoon" variety. This type presents only one cutting edge to the work, but is easily made and can be gaged with less difficulty than a fluted reamer. It is also readily sharpened, being stoned only on the top flat face.

* * *

COMBINATION HEAT-TREATING FURNACE

BY ALLOY

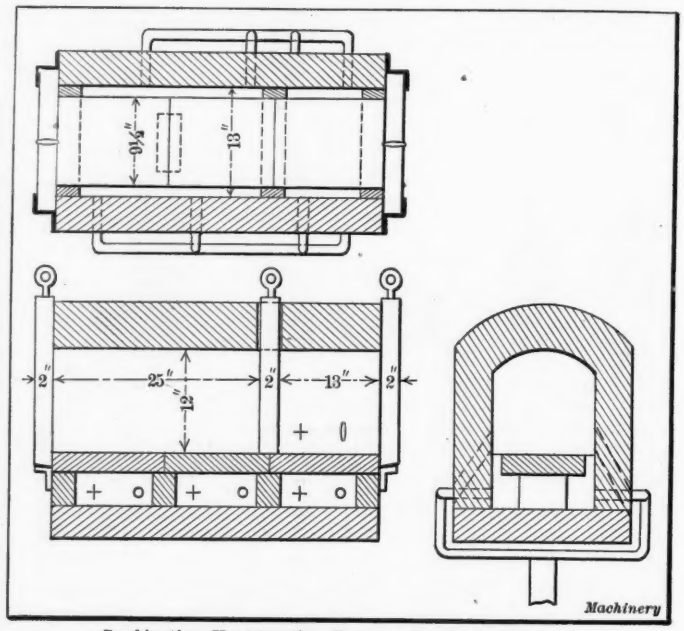
The company by which the writer is employed went to considerable trouble in looking over standard types of heat-treating furnaces in the hope of finding an equipment which would meet existing requirements. We were badly in need of space, and as the range of our work to be heat-treated is quite extensive it appeared that two furnaces were really necessary. At the same time, we were trying to find one furnace which would meet all requirements. The conditions will be better understood when it is known that the range of work to be handled includes milling cutters 6¾ inches in diameter by 1¼ inch face width and arbors 30 inches in length as well as the general small jobbing work usually encountered in repair shops. The cutters to be hardened are of high-speed steel, while the arbors are to be carbonized.

We considered the case from various angles. It appeared possible to meet the requirements with two standard furnaces, using a casehardening furnace for pre-heating the high-speed steel cutters, and having a second furnace for the high temperatures required for hardening. We also considered the possibility of saving space by eliminating the pre-heating process and using a single furnace for all the work. Allowing for the use of carbonizing boxes, it would require a furnace 40 inches long to handle the arbors, and it soon became evident that this idea was useless because of the excessive cost of fuel when treating small work and of maintaining a furnace of this size under the wear and tear of the high temperatures for hardening high-speed steels.

Interviews with furnace men were far from encouraging. They all derided the idea of getting one furnace that would handle our range of work, and ridiculed any suggestion about making a special furnace for the purpose. As it became evident that we could not buy a suitable furnace, the writer finally set out to build one to meet the requirements of the special work to be heat-treated. The furnace finally produced is shown in the accompanying illustration, from which it will be seen that there are two compartments separated by a partition 2 inches thick. When this partition is lowered there are two independent furnaces, one of which is 13 inches long and the other 25 inches long. The small compartment is provided with extra burners to give the high temperature required for hardening high-speed steel. There are also six burners—three on each side of the furnace—each of which has an independent valve so that each burner can be regulated irrespective of the other five. To obtain an even temperature all through the furnace, all of the valves are thrown wide open, and the regulating is done by the main gas and air valves. When the larger compartment is not in use, the four valves for heating this compartment are shut. The air and gas are mixed before entering the main pipe which leads to the burners, and in this way an even mixture can be obtained.

It will be seen that there is a door at each end of the furnace so that the two compartments may be used independently; this does away with the necessity for raising the partitions except when it is desired to move work from one compartment to the other or to handle work which requires the entire size of the furnace. The doors and partitions are raised and lowered by means of cables which connect with counterweights. This type of door has been criticised by some people because in the event of an explosion there is no outlet for the pressure. With a hinged door, the pressure resulting from an explosion will blow the door open, thus allowing the pressure to expend itself. In the present case, however, the correct mixture of gas and air is insured before the doors are lowered. So far, no trouble has been experienced, and it may be mentioned in favor of this type of door that it is found extremely useful when it is required to heat-treat the ends of pieces that are too long to go into the furnace. In such a case, the work is pushed into the furnace and the door lowered on it. This keeps free air away from the heated part of the work and does away with the danger of damage from oxidation.

A hinged iron leaf is provided at each end of the furnace which can be swung out of the way when it is not required. When the leaf is in position it comes flush with the top of the bed of the furnace. When removing the work from the furnace these leaves are found very helpful, particularly when heavy carbonizing boxes are being handled. The box can be dragged out of the furnace onto the leaf, where it is more convenient to obtain a good grip on it. Men who have experienced trouble in getting hold of work while it is still in the furnace will readily appreciate the value of this attachment. The bed of the furnace is made in three equal sections and we usually keep two or three extra sections in



Combination Heat-treating Furnace for Carbonizing and Hardening Operations

stock. The small compartment is used for work requiring extremely high temperatures, and this end is also used for a variety of odd jobs. As a natural result, the bed at this end of the furnace gives way before the opposite end is worn out. The worn bed can be easily taken out and replaced whenever necessary.

The end view of the furnace shows the positions of the extra burners for heating the small compartment. The horizontal burner on each side is one of the six regular ones which heat the furnace. The inclined burners are the two extra ones which are used to raise the temperature of this compartment sufficiently for hardening high-speed steel. These extra burners throw their heat above the bed at such an angle that the flame does not strike the work, but strikes the top of the furnace, from which it is deflected in a way to give the best possible results. In handling the large high-speed steel cutters referred to in a previous paragraph, the work is laid in the large compartment and uniformly preheated to a temperature of about 1800 degrees F. The partition is then raised and the cutters drawn through to the small compartment, in which the temperature of the work is quickly raised to 2200 degrees F. The work is then taken out and plunged into an agitated oil bath. From the preheating to the final compartment, the work does not come in contact with the air, so that there is no possibility of damage from oxidation. For small work, it has been found very handy to use two sizes of boxes for carbonizing, one 9½ inches round and the other 12 by 9 inches. For a small odd job, one of the boxes will go into the small end of the furnace. When there is enough small work to fill two boxes, the large end is used.

PATENTS—SOME ESSENTIAL FACTS FOR THE ENGINEER*†

INFRINGEMENT—PATENT OFFICE PRACTICE—VALUE OF PATENT—SCOPE OF PATENT

Most engineers, designers and mechanics will find it of great practical advantage to know something about patents and the elements of patent law. Such men are engaged in all sorts of industries and simply cannot afford not to know something about these subjects, because our factories are making patented articles on patented machines to a great extent, and the men working in or for those factories are trying to increase production or get more business, or at least to make sure to keep their own jobs and get better ones, perhaps.

Now, as a designer or experimenter, you may make something new, and the question will come up whether you or the company you work for ought to try to protect it by a patent. Or it may be found that a competitor has patents covering his articles, or makes the same thing you do more cheaply or better through the use of a patented process; and in either case it may be up to you to improve your own product or process to compete successfully. You will have to consider how to get around his patent and, if possible, make something better or at least different from his, with good talking points of its own to help the sales force. Maybe what you do will amount to invention and deserve patenting. You may be called on as the engineer or executive of a plant to determine the value of a patent which someone wishes to sell you, or give you a license under; or you may have to appraise the assets of a company, which are made up in part of good will, patent rights, and the like. Possibly you may have an opportunity to act as an expert witness in a patent infringement suit. In all of these relations you will probably have the aid of a patent lawyer, but nevertheless a clear general understanding of the subject should be of considerable value.

The making of inventions and the American patent system, which has encouraged inventing more than that of any other country, have been tremendous factors in our industrial success. Patented improvements are constantly making many things better and cheaper. For example, the price of sulphuric acid is about fifteen times less than it was in 1807, and about one-half of what it was in 1870. And there would not be many inventions if patents were not granted, since few people work hard on new things except when they are stimulated by the hope of substantial reward. Under our present system, Americans are always willing to try out new ideas, to see if they will work. That reminds me of the small boy who had the investigating spirit. He came home from Sunday school and went right upstairs, and presently his mother heard an awful splashing. So she went up, and there he was standing in the bath tub with all his clothes on, and water all over the floor. "For goodness sake, Willie, what are you doing?" she said. "Why, mother," he replied, "they told us in Sunday school about the Lord walking on the water, and take it from me, it's some stunt." Of course, he didn't mean to be sacrilegious.

What an Engineer Ought to Know about Patents

In considering what an engineer ought to know about patents, the subject opens up roughly, under these heads: (1) What a patent is, how it is obtained, and what it purports to give you; (2) how to determine the scope or value of a patent; (3) when it is worth while to make an invention and secure a patent on it; and (4) how in a general way to make use of a patent to get value out of it.

First, then, a patent is a grant in the nature of a contract between the United States and the inventor. The government gives the inventor the exclusive right, for seventeen years, to make, to use, and to sell, whatever it is that is covered by the patent. No one else can make it, or use it, or sell it, without his permission. If they do, they are infringing the patent, and he can bring suit to stop them, *i. e.*, get an injunction against the continuance of their infringing operations. He can also collect three-fold damages for what they have done, or the profits which they have made by the infringement. The inventor, in return for this monopoly, makes his invention public, by clearly describing it in his patent, so that the public are taught how to practice it; and at the end of seventeen years the patent runs out, and then every one is free to practice it. The inventor might have kept his discovery a secret. That is why the United States gives a monopoly for seventeen years in return for his disclosure of the invention to the world, by means of the patent.

In order to be patentable a thing must be novel and useful; and the exercise of the inventive faculties must be involved in the production of it, as distinguished from simple mechanical skill. No general rule can be laid down to define when the making of a new thing involves invention, although there are many rules as to when it is not invention. But the distinction from an older thing must be more than mere excellence in workmanship, or the improvement which would naturally occur to a skilled engineer or workman in that line. For instance, the patent which covered the first circular saw mill adapted to sawing logs was declared invalid by the supreme court, as not amounting to invention, since they found the patentee had merely made a larger machine like earlier ones which were adapted for sawing laths.

As to the form of a patent, it is made up of a specification, or a describing part; and at the end there is a claim, or usually a number of claims, which state in a very concise way exactly what it is that is protected by the patent. For example, a claim for a new chemical product: "As a composition of matter; a phenol-methylene condensation product containing a halogenated phenolic substance incorporated therewith, substantially as described." You will notice that this describes what the invention actually is, instead of enumerating its advantages, which are stated in the body of the specification.

Patents may be taken out for new inventive compositions of matter, like the above; for apparatus or machines; for articles of manufacture, such as a new kind of phonograph record having a different kind of record groove formed on it; and for new processes. Not all processes are patentable. For instance, the mere statement of a law of nature is not. In the patent of S. F. B. Morse for the telegraph, the eighth claim was held void by the supreme court, as being merely for the use of an electric current for marking intelligible signs at a distance. He did not discover the electric current, and claiming just one principle of nature, as he did in that claim, was held unpatentable. If his process, as claimed, had been for the use of several laws of nature, in an orderly manner, to produce a new result, it would have been patentable. The use of a series of steps involving chemistry, light, electricity, or other natural sciences; or of a series of steps, all working to the same end, and which may be performed by hand or by different mechanisms, may be patentable as processes. A case in point is the art of weaving, when it was new. Claims for a machine cover a number of parts which work together to produce a new result. It doesn't matter if all or some of the elements of the combination are old by themselves, so long as the combination of them is new, and makes a new result, which is not obvious. But if the elements of the claim do not cooperate together, the claim is an aggregation, and unpatentable. For instance, the man who first put a rubber on the end of a lead pencil had his patent knocked out, since the court said both the pencil and the eraser were old, separately, and they acted separately, whether they were joined together or not.

What Constitutes an Infringement

The claims show what is protected by the patent. It is infringed by any device which one of the claims describes. If the claim has some elements described which are left out of the other device, it is not infringed by it. For instance, a claim for a machine might include a part that had to be

* For additional information on the subject of patents and kindred matters see "Filing Your Own Patent," by Ford W. Harris, published in the February, 1914, number of MACHINERY, and other articles there referred to.

† Address by Dyer Smith presented to the students of Lehigh University, South Bethlehem, Pa., January 9, 1914.

moved periodically, and a spring for moving it. That would not be infringed by a machine that left out the spring, and depended on gravity. But it would be infringed if a weight was substituted for the spring, in most cases, as that would be the recognized equivalent of the spring. If the patent stated that it didn't matter whether the part was moved by a weight or a spring, or by the positive actuation of another part which was clearly described, and then the claim included broadly "means" for moving the part, it would be infringed by any of these devices.

To get a patent, the application is prepared and filed in the patent office together with a filing fee of $15. The application consists of a petition; an appointment of an attorney to represent the applicant, unless he wishes to prosecute the application himself, as he has the right to do; the specification, describing the invention clearly and fully in connection with drawings if it is such an invention as can be illustrated by drawings, and having at the end a number of claims, as previously described; and an oath. A patent is a highly technical instrument, and its value depends chiefly on the skill with which it is written and prosecuted before the patent office, and particularly on the way the claims are worded when the patent is finally allowed. Therefore, it usually does not pay to attempt to do without an attorney, or to employ an attorney of doubtful standing or ability.

The patent is to be applied for by the real inventor, alone, if he made the invention by himself; and by two or more persons, jointly, if they made the invention jointly. If one man makes the invention and another puts up the money, they must *not* apply for the patent jointly, since, if it can be proved later that it was not the joint invention of both of them, the patent will be invalidated. So, also, the application must not be made in the name of the employer or superior of the inventor. But the employer is the real inventor if he conceived the invention, gave it to the employe to work out, and told him what to do; and the employe, in putting it into practical form, did no more than any good mechanic or chemical worker would do under the circumstances, in employing common knowledge. In this case, the employe may exercise invention in improving on the conception of his chief; and then two applications might be filed: one, on the broad idea, in the name of the chief and the other, on the improvement, in the name of the employe.

Similarly, if the invention is really the joint effort of two or more persons, the patent should be applied for in the name of all, since if it can ever be shown that the patent was taken out by less than all the inventors who jointly made it, it is invalidated. An invention is made jointly by two or more people when its conception and working out is the result of their joint effort. One suggests some features and the other, other features; and these different features cooperate in the operation of the complete machine or invention, and both men work out these features together.

I may say here, in passing, that many large corporations employ regular staffs of experimenters and inventors; and most of these concerns have contracts with these employes, which provide that the latter are to assign to the company all inventions made by them in the regular course of their employment. If the employe makes an invention at home, or away from the company's plant and out of hours, or on something not connected with his regular employment with the company, it belongs to him, unless, perhaps, he has contracted absolutely to assign to them everything he invents for a certain period. If there is no contract at all and you make an invention in the line of your regular work, for a person or corporation, the title to the invention remains in you and you cannot be compelled to assign it to your employer. In this case, however, your employer has a shop-right to the invention, or a license to make, use or sell the invention without paying you royalty. On the other hand, if you have taken out a patent, he cannot prevent you from licensing other parties to make, use and sell the patented device, or from selling the patent outright, subject to your employer's license, or from making, using and selling the device yourself. Of course, if you were employed by some concerns, and did these things, you might lose your job, which is a point to be considered.

Another point to be noticed is that if you have no written contract to assign your inventions to the company, but you always have done so and it is expected of you, there may be an implied contract so that they could force you to do so.

The Practice of the Patent Office

To return to the matter of securing the patent, we will assume that the application papers and drawings, with the filing fee of $15, are filed in the patent office. There are forty-odd different examining divisions in the patent office, in each of which are examiners who examine only certain particular classes of invention, and your application goes to one of these. For instance, if your invention is in wireless telegraphy, it is placed on the desk of a man who spends all his time in acting on wireless telegraph applications. In a month or more, or maybe less, he reaches your case, reads it, notes certain objections or criticisms, and proceeds to study the claims. He compares these, separately, with his knowledge of what has been done before, and searches the files of patents relating to wireless to find an anticipation for the invention expressed in each claim. He has at his command all the wireless patents of both the United States and foreign countries, and all the technical magazine articles and books of the world, relating to wireless, all classified according to the different subdivisions of the subject.

After his search, the examiner writes a letter, in which he probably rejects some of the claims, in view of certain earlier patents. The inventor, then, through his attorney, studies this action and amends the application, canceling some of the claims, perhaps, changing others somewhat, adding new ones, and arguing that others are all right as they stand. In course of time the examiner answers this, either by allowing the case or by again rejecting certain claims; the attorney answers again, and this process is kept up until either the case is allowed or finally rejected. If this latter happens, the inventor has several appeals permitted him to the Board of Examiners in Chief, then to the Commissioner of Patents, and then to the Court of Appeals of the District of Columbia.

It may happen that the application which you have filed covers the same invention, in whole or part, as other applications of other inventors which are pending before the patent office at the same time. For example, Alexander Graham Bell filed his first application for a patent for a telephone in February of 1876, on the very day that Elisha Gray filed a caveat covering the same general idea.

When two or more patent applications are pending before the patent office at the same time, the office determines to which one the patent should be issued by means of a proceeding known as an interference. This is started by the examiner arranging for a claim or claims in the same language to be adopted in all the interfering applications. In due course of time, if the interference is contested, testimony will probably have to be taken to determine who is the real inventor. It is not simply a question of which man files his application first in the patent office because if the opposing inventor had, for example, actually built the machine and tested it, or otherwise practiced the invention at an earlier date, he would be likely to win. It may be quite a complicated matter, but the main dates involved are, first, when you conceived the invention in your mind; and second, when you reduced it to practice by actually making and testing it successfully or, what is counted as the same thing, by filing an application on it in the Patent Office.

If you file your application before the other man has conceived the invention or done anything, you win, of course, without more ado. But if he reduced it to practice by actually making and testing a specimen of the invention before you did, and before you filed your application, he wins. If, however, you can prove that you conceived it first and worked steadily and diligently on the idea, perfecting it and making it practical from before the time your rival entered the field until you reduced it to practice or filed your application, you win. This shows the great advantage of keeping accurate records of what you do in conceiving and perfecting an in-

vention, and signing and dating all your sketches and records and having them witnessed, preferably by someone you trust, who can understand the invention and to whom you describe it. It also shows that if you have something that seems valuable and you have not or cannot reduce it to practice, you should file an application as soon as possible, since your delay, if not excused, may cause you to lose an interference, if you should get into one.

The Protection that a Patent Affords

As to the question of what protection a patent purports to give you; it gives you the right to exclude everyone else from making, using, or selling the thing patented, without your permission. It does not, necessarily, give you the right to make, use and sell the thing yourself, although it is a very common mistake to think that it does. You may not be able to make, or use, or sell, your own invention—even though you have a perfectly good patent on it—because your invention may be an improvement on an earlier patented invention, and the use of yours may infringe the claims of the earlier patent. To illustrate: Alexander Graham Bell was granted the first patent in telephones, and this was of an all-embracing character. The courts held that Bell had discovered, and that his patent in 1876 pointed out, the great principle that electrical impulses, induced by the vibrations of a current produced by sound waves, correspond in form and character to the sound vibrations which they represent. This is embodied very broadly in a claim in his patent, as follows. "The method of and apparatus for transmitting vocal or other sounds telegraphically as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

In the course of time it developed that this claim was so broad as to dominate the whole telephone industry. Practically, no improvement in the telephone could be used without using Bell's invention and infringing his patent until the end of the seventeen-year life of the patent. It was what is called a pioneer patent. Bell's actual device was crude, of course, and later inventors improved on it and took out patents on their improvements. For instance, Edison invented and patented the carbon transmitter. This was a long step in advance, for Bell's first telephone, using a magneto instrument like the present receiver for both transmitter and receiver, was much too faint. Edison's patent was a pioneer patent so far as transmitters of the carbon, or variable resistance type go; but it was merely an improvement on the broad invention of Bell, and Edison's transmitter could not be used without infringing the broad claim of Bell's earlier patent, since using the carbon transmitter in any telephone system would cause electrical undulation similar in form to the vibrations of the air accompanying the vocal sounds of the person using the telephone, as claimed by Bell. Therefore, Edison could not use his invention without Bell's permission. Also, neither Bell nor any one else could use Edison's transmitter without his permission. And when later inventors improved on Edison's transmitter, they could not use their improvements without his permission, if using or making their improvements involved using or making the combination of elements claimed in the Edison patent; and at the same time, neither Edison nor anyone else could use their patented improvements on the Edison transmitter without permission.

All this shows that before you buy a patent, or build a plant to manufacture something under a patent, you should first make sure that you are free to use your own patented device or process. A good patent lawyer should be employed to make an infringement search, and report to you what your rights are. Maybe all of the earlier patents in your line having broad claims have run out. Or maybe, while some of the earlier patents have pretty broad claims, your invention reaches its result in an entirely different way and does not infringe any of the claims of the earlier patents. Or you may find that while some of the earlier patents have claims which you seem to infringe, they are, as a matter of fact, broader than they had any right to be because of what was already old at the time they were taken out. In this case, the earlier patents will have to have their claims narrowed by construing their language to mean only what the patentee really did invent, and in that case you may not infringe. Or your lawyer may tell you that you infringe some patent with the exact device you intended to make, but that if you make certain changes you will escape the patent. Or it may be that you cannot get around some broad earlier patent at all, and then, if you cannot show that the earlier patent is invalid for some reason, you will have to either sell out or take your chances of not being molested, or else just keep the patent for what it may be worth to you to prevent competitors from using your patented improvement.

The Scope of a Patent

The scope or value of a patent, as you will now readily understand, depends largely on the claims. The claims are broad when it is hard to get around them and narrow when it is easy to get around them. As a general rule, the more details that are set forth in a claim the narrower it is, because competitors can supply other details or leave some of them out, and so avoid infringing. The Bell telephone claim was very broad, because it covered the method and apparatus necessary for telephone communication in its essentials, without being limited to any details. If Dr. Bell and his attorney had not realized the true fundamental scope of his invention, and had claimed it only by its details, it could easily have been gotten around and the Bell companies would not have had the monopoly they did for the life of his first patent. For example, Bell might have claimed "Apparatus for transmitting vocal or other sounds telegraphically, consisting in an electrical circuit, connecting two distant points; a magnet situated at each of said points, the coils of which are included in said electrical circuit; a diaphragm of soft iron positioned to act as a vibrating armature for each magnet; and a mouthpiece in front of each diaphragm, whereby vocal or other sounds impinging on either diaphragm cause electrical undulations similar in form to the vibrations of the air accompanying the said sounds to pass over the line to the distant coil, substantially as set forth."

That would claim the invention only with respect to the particular means for carrying it out, which Bell had in mind when he filed his application—one main line circuit in which the magnetic transmitting and receiving instruments are placed, the electric impulses generated directly by the sound waves passing over the line. That would not have been infringed by Edison's invention, since his sending instruments are not in the main line circuit at all, as claimed in my hypothetical claim, but in local circuits with the batteries and primaries of the induction coils; and because Edison's transmitters do not include magnet coils, but are devices for varying the resistance in the closed local circuit with the battery.

So you see how Bell might have lost his monopoly by claiming his invention too narrowly—that is with too many details in the claim. But he could very well have had some narrower claims like the one I made up, in addition to his broad claim, and then if the courts had held that he wasn't entitled to the broad claim but was entitled to some of the narrower claims, he would have had a monopoly so far as the narrow claims went. Each claim is like a separate invention, and they all have to be considered separately, without reference to each other.

When it is Worth While to Take Out a Patent

The question of when it is worth while to make inventions and take out patents should be considered in a business-like way, and not gone into as a blind speculation. The farmer who passes the long winter evenings by inventing and patenting a non-refillable bottle probably loses his time and money, since he doesn't know what the practical conditions and needs of the bottling business are. But he does know something about plows, and if he sees how an improvement can be made which will cheapen the plow or make it do better work, he has something he can figure on. You, as engineers, are in a better position to realize on inventions than the farmer, for engineering problems are involved. Suppose, for instance, you are familiar with the coal business and get an idea that would seem to make the dumping of coal cars a much cheaper

and quicker proposition, and would simplify the construction of the cars. You calculate as an engineering proposition that it can be done practically and that there are no objectionable features about the scheme which would overcome the advantages. You look over the trade catalogues and decide that your scheme would really effect a considerable saving over any of the advertised devices, so much so that different concerns should be very glad to get it.

Then you go to any good patent lawyer and have him make or have made what is called a preliminary examination. This is inexpensive, and results in showing you the four or five earlier patents which are nearest to your scheme. Some of these may be so similar that it is evidently not worth while going to the expense of applying for a patent, in spite of the fact that you never heard of such a device being on the market. Or it may be that yours is quite different, or again that some of these patents are similar in a general way to yours, but lack some important details, which make yours a practical success, while they were practical failures. If your attorney tells you that the improvement is something that amounts to invention, as it probably does, the patent that you then apply for and get will be valuable in spite of being only for an improvement, since the improvement is needed to make the device a real practical success.

While I have emphasized the necessity of only trying to patent practical things, that does not necessarily mean that what you have invented must be in highly perfected form before you apply for your first patent. If you feel that you have the principle of something that will work, and that there will be a future demand for, it does not so much matter that your first device is crude. Bell's first telephone, Edison's first phonograph, and Selden's automobile were all crude; but their patents were gold mines because they described the big, fundamental ideas that, in the form of patent claims, gave them broad protection. The crude devices they described as particular embodiments of their inventions would work to some extent, and illustrated the principles which the inventor had discovered.

What to do with Your Patent

This brings us to the question of what to do with the patent when you get it. If you already have a manufacturing business in which your invention can be used it is simply a matter of stamping "Patented" with the date, on the thing you make—if the patent is on a product of your factory—and seeing to it that your rights are respected. When your competitors know that you operate under a good patent, they will be likely to keep off, or will stop upon your notifying them that they infringe. Sometimes it is necessary to actually bring suit, and the defendant may decide after you have started the suit that it is better and cheaper for him to give up rather than to fight the suit to a finish; and either pay you a royalty in future, or get out of that line altogether. If your competitor is big and rich, and unscrupulous, it will be a question whether the expense of fighting him through to a finish will be compensated for. This should be calculated in advance, so far as possible.

Once you have won one suit on your patent and had the patent declared valid by the court, you are in a much better position; and you can almost immediately get preliminary injunctions against other infringers, to have their operations stopped. You should understand that when you bring suit for the infringement of a patent, the defendant can—in most cases—allege and attempt to prove that your patent is invalid, as well as that he does not infringe it. It may be invalid, for example, because the claims are too broad in view of earlier patents. The court may either decide that your patent is valid and infringed, as to the particular claims you allege are infringed, or that some of them are; or that it is valid but not infringed in the particular case, decided, or that it is invalid. If the verdict is against you, and the matter is of sufficient importance, you may appeal from the United States District Court where the case was tried to the United States Circuit Court of Appeals for the circuit in which that particular district court is situated.

The result of having your patent sustained by a suit may be to cause all the infringers, or those who would like to use the invention, to pay you royalty for the life of the patent. Or you might decide to license a limited number, giving each one rights for a different part of the country on payment of royalty; or, of course, you could sell outright, or else give an exclusive license to one concern alone.

If you take out the patent as an individual, without any manufacturing connections, the first thing to decide will be whether to manufacture under it, sell the patent, or license one or more parties to use it on payment of royalty to you. To get the greatest advantage out of any of these courses requires the expenditure of thought, time and money. This is obvious as to the manufacturing. Perhaps you can sell out, if the patent is for something useful, without much trouble; but the patent will have much more value after it has been declared valid as the result of a suit brought for its infringement. A good scheme for an individual patentee who does not expect to manufacture, himself, is to form a small company to develop and exploit the invention, and thus get in some money as working capital. You will then be in good position to bargain with people whom you may hope to interest or to give licenses to, and to protect your rights in such fashion that it will be plain you are not to be trifled with. I know one man who recently took out some broad patents on automobile mechanism, started various suits against owners of automobiles who went back to their dealers for protection, and eventually signed a license agreement giving an important association of manufacturers rights on royalty, from which he is realizing a very considerable sum. Another inventor I have in mind—a chemist—has associated himself with another man as a sort of manager; and they are continually forming small companies to exploit his inventions, which they license manufacturers to use and thus make a good income.

Conclusion

In conclusion, patents have been a tremendous aid to the business and manufacturing of the country, and to the inventors themselves when they have been good business men or have associated themselves with good business men, and when they have applied good practical and engineering sense to their problems. The patent system may well be improved in some ways to make its operations cheaper and quicker, and something has lately been done in this direction, but legislation which has been proposed to cut down the inventor's reward, or that of a corporation to which he sells his patent should not be approved, and various engineering societies are on record as being opposed to such changes.

* * *

WESTINGHOUSE ELECTRIC VETERANS' ASSOCIATION

The employes of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., who have been in its employ for a period of twenty years or more held a meeting and organized the Veteran Employes' Association of the Westinghouse Electric & Mfg. Co., Saturday evening, February 21. About 325 employes of the company are eligible to membership and approximately 315 of these were at the meeting. L. A. Osborne, vice-president of the company, was toastmaster at the dinner. E. M. Herr, president, Charles A. Terry, vice-president, and James J. Barrett, representing the shop, made speeches. Guy E. Tripp, chairman of the board of directors, was elected an honorary member of the association, as was also Mr. Herr, neither of whom have been connected with the company the required twenty years. A standing toast was drunk to George Westinghouse, who was unable to be present on account of illness.

* * *

It is stated in the *Railway Age Gazette* that a large increase in the capacity of passenger locomotives has been made possible by the use of alloy steel, properly heat-treated, for the reciprocating parts. This material effects a considerable reduction in the weight of the counterbalances, and thus allows an increased load to be applied to the driving-wheels. Hence, the boiler can be materially enlarged and the capacity of the locomotive as a whole increased without adding to the total weight.

COUNTERBALANCED AND INDEXING FIXTURES

VARIOUS TYPES OF SPECIAL FIXTURES ILLUSTRATING DIFFERENT METHODS OF COUNTERBALANCING AND INDEXING

BY ALBERT A. DOWD*

Work of irregular form having several holes to be machined, and castings or forgings in which a single hole is to be bored at one side of the piece, require special fixtures upon which they can be clamped for the machining operations. There are a number of conditions which affect fixtures of this kind; for instance, the work may be small and of light weight,

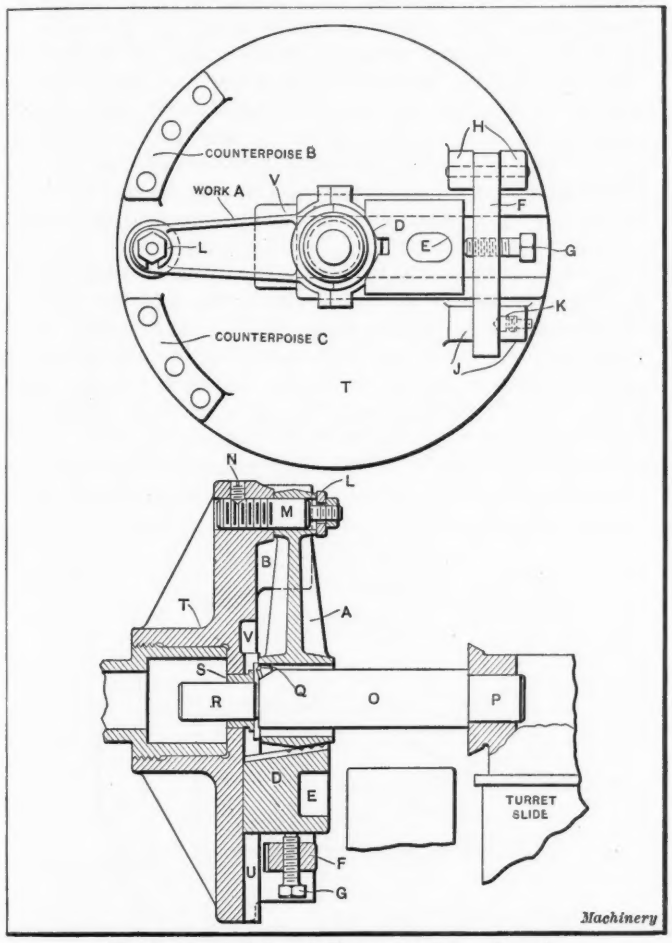


Fig. 1. Counterbalanced Fixture for Connecting-rod

or it may be large and very heavy; it may have several parallel holes, or they may be at various angles, sometimes even converging to a common center; the part may be very much one-sided; it may have been partially machined in some previous setting, or perhaps is a rough casting or forging. All these things affect the design of the fixture, as does the type of machines to which the fixture is to be applied.

Counterbalanced fixtures are used only on the class of machines where the work itself revolves, such as engine lathes, turret lathes, boring mills and cylindrical grinding machines. Indexing fixtures, however, can be used on all the foregoing, and also on many other machines, such as drill presses, milling machines, planers, shapers, slotters, etc. Very frequently indexing fixtures are supplied with some provision for counterbalancing, when used on the first-mentioned group of machines. Sometimes this counterbalance is so arranged that it can be moved to suit different conditions, and, in other cases, it is made solid with the fixture and is carefully balanced at the time the fixture is made. There are two things which must be carefully considered before any attempt is made to design a fixture, *viz.*, the machine most suited to the work in question, and the speed at which it will have to run in order to be thoroughly efficient. The latter is important if a counterbalance is to be used, because more care must be exercised in the balancing if the fixture is to be run at high speed. In addition to this, a high-speed fixture should be arranged with a suitable guard (if cutting lubricant is to be used), so that the operator will not have to wear a bathing suit. It is evident, therefore, that these things should be thought of before the design of the fixture is started. This is one of the cases where "an ounce of foresight is worth a pound of hindsight," for when a device of this kind is finished and ready to put on the machine, it is very annoying to be obliged to hold up the work a couple of days while a guard is being made and fitted. Incidentally, it does not redound to the designer's credit, for it should have been thought of in advance.

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A Few Points on Fixture Design

1. Rigidity. This is of prime importance in every kind of a fixture, and when the fixture is designed for use in a horizontal machine, the overhang from the end of the spindle should be made as short as possible in order to prevent vibration.

2. Positive location for the work and rapid-acting clamping devices of such a nature that it is not necessary to disturb them when indexing the fixture. In this connection it might be mentioned that the writer has seen indexing fixtures which were so designed that the clamps holding the work required loosening before indexing. Needless to say, this is very poor design.

3. Method of obtaining accurate indexing with provision for taking up wear at the locating points. Either taper pins or taper wedges are suggested.

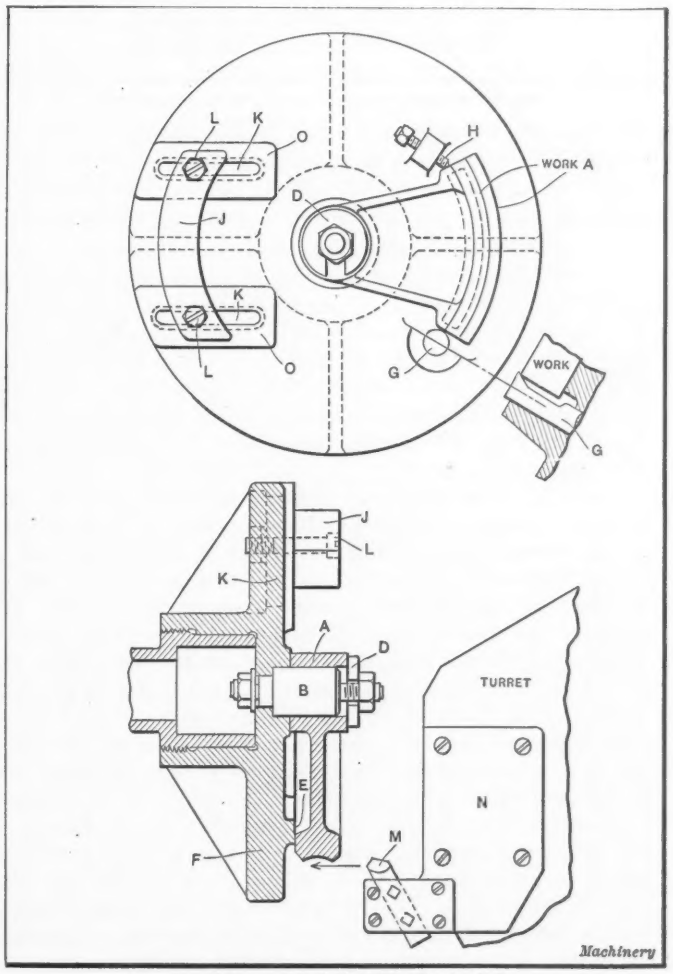

Fig. 2. Fixture with Adjustable Counterbalance

4. Adequate protection from dirt and chips so that errors in indexing will not be caused by imperfect contact at locating points. This point is of special importance on fixtures indexing in a horizontal plane, as for example, those used on a milling machine or a vertical boring mill.

5. The method of counterbalancing. If the counterbalance is to be a part of the fixture, the weight must be figured so that it will slightly exceed the portion which it balances in

order that it can be drilled out or chipped off when assembled with the work in position, to obtain a smoothly running fixture. A sliding counterpoise is a very good arrangement when several pieces of a similar kind are to be machined, for it can be so proportioned that it will take care of varying conditions.

6. Rapidity of handling, both in clamping the work and in the operation of the indexing mechanism. As these two points make considerable difference in the cost of the fixture,

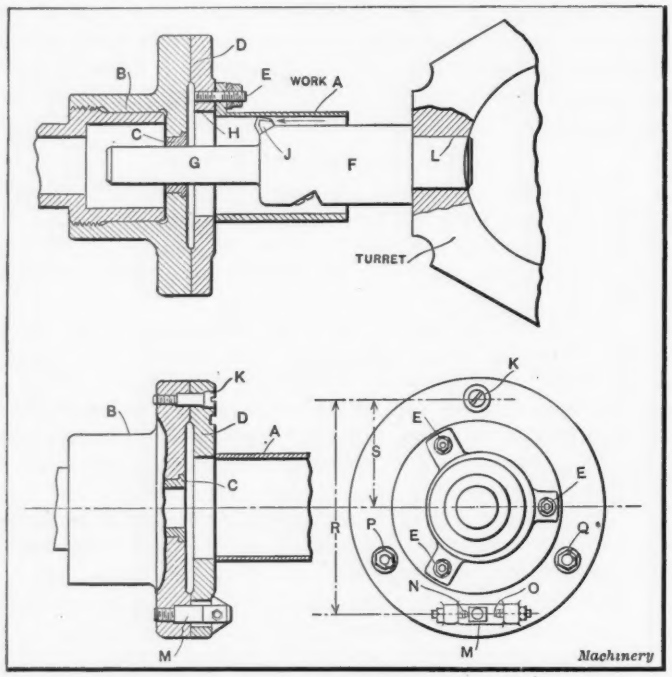

Fig. 3. Swinging Fixture for Eccentric Piston Ring

they should be proportional (to a certain extent) to the number of pieces which are to be machined. In fact, the entire fixture should be designed with this point continually in mind, so that its cost as a whole will not be too great.

Counterbalanced Fixture for a Connecting-rod

A very good example of a simple counterbalanced fixture is shown in Fig. 1. In this case the work *A* is a steel connecting-rod forging which has been faced on both sides and the wrist-pin hole in the small end has also been bored and reamed in previous operations. This fixture is used to bore and ream the large hole at a fixed distance from the wrist-pin hole and parallel thereto, the machine being a horizontal turret lathe. The body of the fixture *T* is of cast iron and is screwed to the spindle. The steel stud *M* is screwed into the body and is held in position by the pointed set-screw *N*. It is located at the correct distance from the center of the spindle and is turned down and threaded at one end to receive the U-washer *L* which is clamped down on the work by the hexagon nut shown. The sliding V-block *D* is dovetailed to fit the slide *U* in the body of the fixture. This centers the work from the outside of the forging and it should be noted that it also has a holding down action due to the angularity of the V-block. This is clearly shown in the lower view. The lugs *H* and *J* act as supports for the swinging latch *F*, and the detent pin *K* keeps the latch in position. The block *D* is clamped against the work by the square head set-screw *G*, located in the latch. The elliptical hole *E* is a finger hole by which the block is pulled back out of the way when removing and placing a new piece of work in position. The cored pocket *V* in the body of the fixture is provided so that the V-slide can be planed without difficulty, the pocket allowing a place for the tool to "run out."

The lugs *B* and *C* serve to counterbalance the weight of the latch and blocks on the opposite side and are at first proportioned so that they are somewhat heavier than necessary. After the work is put in place on the fixture it is carefully balanced by drilling into these lugs until sufficient stock has been removed to secure this result. Attention is called to the fact that the counterbalance is located as far from the center of the fixture as possible. This is done in order to make the weight more effective. A hardened and ground tool steel bushing *S* is located in the fixture body and acts as a guide for the boring-bar pilot *R*. The bar *O* is turned down at the rear end, as shown at *P*, so that it fits the turret hole. A recess in the fixture allows the boring tool *Q* to pass slightly beyond the work. A pilot bushing in the spindle might have been preferable, in that there would have been more space in front of the tool. If this had been done, however, the fixture would not have been self contained.

Adjustable Counterbalanced Fixture for a Worm-gear Sector

A condition which is somewhat out of the ordinary is illustrated in Fig. 2. The work shown at *A* is of two different sizes. The outside diameter is almost the same, but there is considerable difference in the weight of the two castings, one of them having a much wider rim than the other and also a heavier web section. Therefore it was necessary either to make the fixture in such a way that it would take care of both pieces, or else make two fixtures. As all other points in design would be the same, it was decided to make a movable counterpoise which could be adjusted to take care of the difference in weight.

The fixture body *F* is of cast iron, and is screwed onto the spindle as shown in the lower view. The locating stud *B* is shouldered and is held in place by a nut and washer on the inner end; the outer end is turned down and threaded to receive a hexagon nut which clamps the work through the U-washer *D*. The pointed set-screw *H* is set at a slight downward angle and forces the work over against the stud *G*. The partial section shows how the angular part of the stud tends to overcome any tendency to lift or strain the casting out of

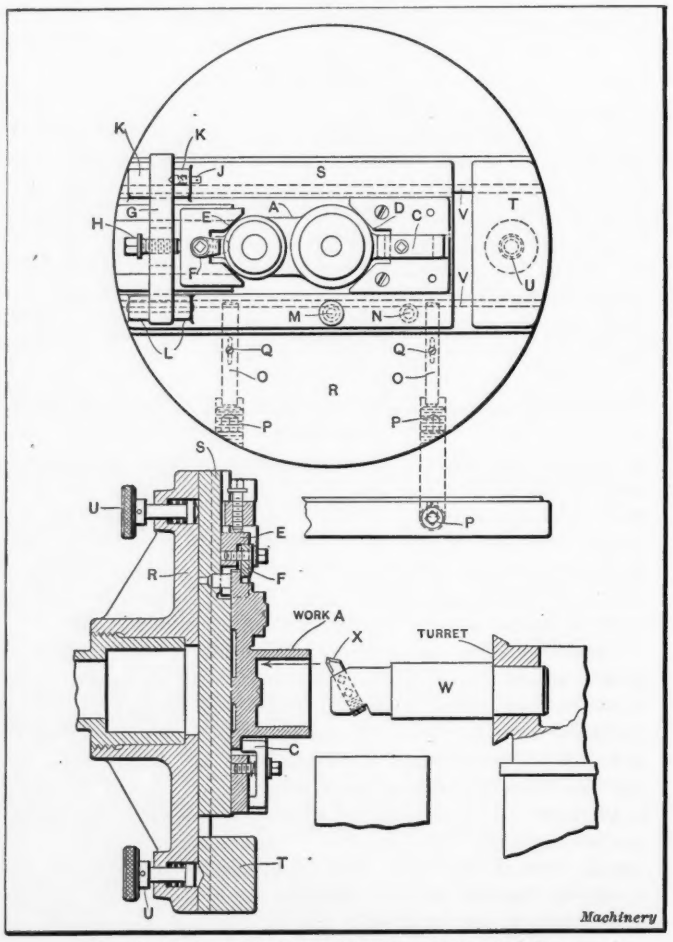

Fig. 4. Fixture with Adjustable Slide and Counterbalance

its correct position. The circular pad *E* forms a resting place for the work. The counterpoise *J* is a cast-iron segment resting on the two finished surfaces *O*. Two slots *K* permit the passage of the screws *L* which clamp the counterpoise in the desired place. An enlargement of the slots on the back of the body serves to prevent the hexagon nuts from turning when the weight is being adjusted. The lower part of the illustration shows the tool-holder *N* fastened to the face of the turret and ready to take a straight cut on the outside of the

sector with the tool *M*. This arrangement was very satisfactory in every respect. The two sectors were put in position and the counterweight adjusted for each piece, the pads being marked by a scratch line so that the counterweight could easily be placed in either position.

Swinging Fixture for an Eccentric Piston Ring

The work *A* shown in Fig. 3 is a cast-iron ring-pot from which eccentric packing rings are turned and cut off. Previous to the machining operation indicated, these pots are rough-ground on the back of the clamping lugs *E*, and are also

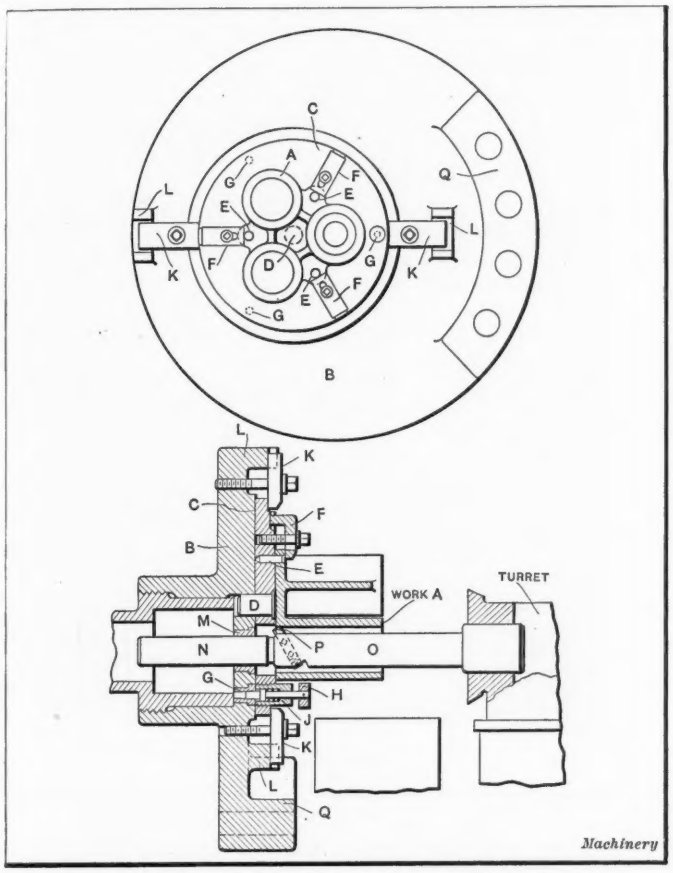

Fig. 5. Counterbalanced Indexing Fixture for Triple Cylinder

jig-drilled at these points. The customer for whom this fixture was designed did not wish to go to the expense of a special attachment for boring and turning eccentric at the same time. Therefore it was considered expedient to design the holding device so that it could be set over to produce the proper amount of eccentricity without re-setting the casting. The machine on which the work was done was a horizontal turret lathe of standard make.

The work *A* is located on the three studs *E*, and held fast by nuts and washers. The body of the fixture *B* is of cast iron and is screwed onto the end of the spindle. It is fitted with a bushing *C* which acts as a guide to the pilot end *G* of the boring-bar *F*. The swinging plate *D* is pivoted on the shouldered screw *K*, and it should be noted that this screw is set well down into the body of the fixture to give additional strength. An opening is provided in the plate *D* so that the square stud *M* in the body can extend out through it to act as a stop for the screws *N* and *O* in the swinging plate. These screws are provided with check-nuts so that they can be locked after being properly adjusted. In this particular case, the eccentricity of the ring was 1/16 inch and, as the distance *R* on the fixture was made exactly double the distance *S*, only ⅛ inch adjustment between screw *O* and stud *M* was required to obtain the correct setting. The studs and nuts *P* and *Q* are used for clamping the plate firmly to the body, the holes being slightly elongated to permit the necessary movement. In the operation of this device, the tool *J* in the boring-bar *F* was first used to bore the hole. The plate was then swung over against the stop and the turning tools machined the outside eccentric. Excellent results were obtained with this device.

Counterbalanced Indexing Fixture for a Carbureter Body

The work *A* in Fig. 4 is a brass carbureter body, and the fixture for it is considerably out of the ordinary in regard to the counterbalancing. The shifting of the slide from one side to the other makes it necessary to arrange the weight in such a way that it can be changed quickly from one side to the other, as occasion may require. The machine used with this fixture is a Pratt & Whitney turret lathe. Prior to this operation the casting is milled on one side on a vertical milling machine. It should be noted that a lug is left on the casting at each end for clamping purposes; this is cut off after the machining operations have been completed.

The body of the fixture *R* is cast iron and it is screwed onto the spindle. The slide *S* is fitted to the dovetail *V* in the body of the fixture, and the indexing locations are obtained by a taper pin in the bushings *M* and *N*. The clamping of the slide in each position is effected by the shoes *O*; these are beveled to the same angle as the dovetail and are prevented from turning by the set-screws *Q* which bear against the flat portion of the shoes. The hollow set-screws *P* act against the ends of the shoes and hold them firmly against the dovetailed portion of the slide. The work is located by the V-blocks *D* and *E*, which center the rough casting. The block *D* is screwed and doweled to the slide and contains the clamp *C* which bears against the lug on the casting. The block *E* at the other end is dovetailed on its lower side and fits the slide. The clamp *F* grips the lug and draws it up against the stud shown in the lower view. A latch *G* is pivoted on a pin in the lugs *L* and enters a slot in the opposite lugs *K* where it is retained by the detent pin *J*. The screw *H* forces the V-block against the casting. It will be noted that the latch is so hung that if the machine should be accidentally started while the latch is open, the latter would tend to close without damage to the fixture. This point in design is frequently overlooked and yet it is well worthy of attention.

The counterpoise *T* is of cast iron and is an easy sliding fit in the dovetail of the body, so that it can be removed without difficulty. It is countersunk on its lower side to receive

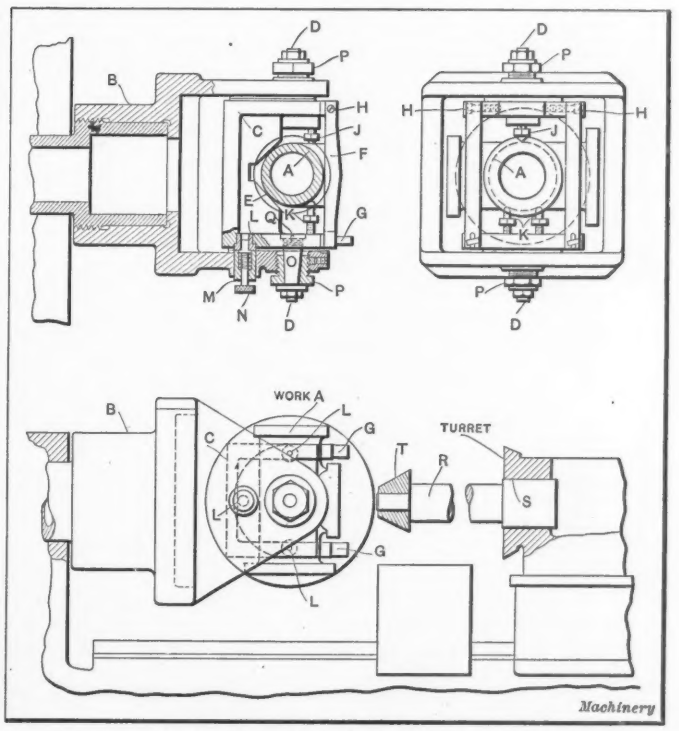

Fig. 6. Indexing Fixture for Cast-iron Valve Body

the spring detents *U*, which are located on opposite sides of the fixture. It is evident that this counterpoise must be transferred from side to side as the slide is indexed from one position to the other, so that the balance of the fixture can be preserved. The boring-bar *W* is shown in position in the turret; the tool *X* is used to rough out the pocket, as indicated by the arrow. This fixture was made up several years ago for an automobile factory in the eastern states, and it was used with good results for one season's production. It was

abandoned only on account of a change in the carbureter design and not because of any fault in the fixture itself.

Counterbalanced Indexing Fixture for a Triple Cylinder

The work *A* in Fig. 5 is a triple cylinder of cast iron with three bored and reamed holes equidistant about a common center *D*. The fixture was used on a horizontal turret lathe. The arrangement of swivel-plate, clamps and counterweight was made as symmetrical as possible so that very little change in the balance of the fixture would take place when indexing from one cylinder to another. The work was milled across the base and the holes *E* jig-drilled before the turret lathe operation took place. The body of the fixture is screwed onto the spindle and is made of cast iron. The swivel-plate which holds the work is also of cast iron and is pivoted on the hardened and ground steel stud *D* which enters the body. The three pins *E* act as locaters and drivers; they are in the plate and match the jig-drilled holes. Three clamps *F* are used to hold the piece, and they are bent over on the ends so that they enter a slot in the plate, which prevents them from turning while the screws are being tightened. They are also slotted so that they can be pulled back out of the way when putting the work in position.

A hardened and ground steel plunger *H* (shown in detail in the lower part of the illustration) is tapered to fit the

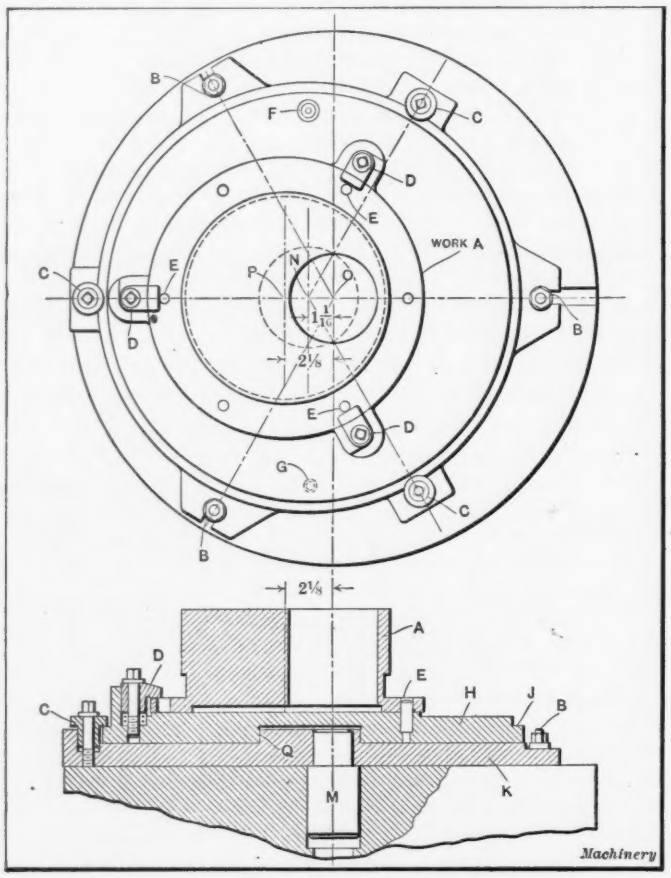

Fig. 7. Indexing Fixture for turning and boring Eccentric

bushings *G* which control the indexed locations as the plate is swiveled. The steel bushing *J* acts as a bearing for the pin and also forms a pocket for the spring. The clamps *K* are loosened when indexing the plate but are set up again before the machining is done, so that rigidity and freedom from chatter are insured. The counterpoise *Q*, in this instance, is a part of the body casting. At first it is somewhat heavier than the parts to be balanced; it is then brought to the required weight by drilling out the stock after the work is clamped in position. Attention is called to the fact that the body *B* contains a bushing *M* in which the piloted end *N* of the boring-bar *O* is guided. It will also be seen that considerable chip room is provided for the tool *P* when it passes through the work. The results obtained by the use of this fixture were perfectly satisfactory.

Indexing Fixture for a Cast-iron Valve Body

The work shown at *A* in Fig. 6 is a cast-iron valve body to be machined complete at one setting. It will be noted that the holes are at 90 degrees with each other, so that the fixture required indexing through an arc of 180 degrees during the process of machining. The casting is in the rough state when placed in this fixture. The cast-iron body *B* is screwed to the spindle, and its forward end is formed like the letter U to receive the swivel-bracket *C*, which holds the valve body. This swivel has a pair of V's which serve to

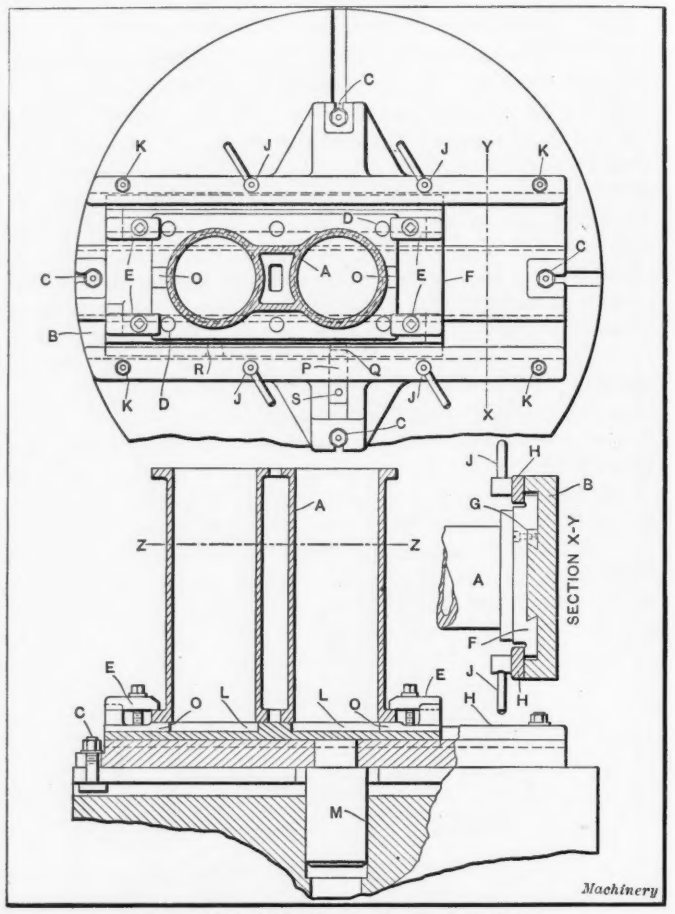

Fig. 8. Adjustable Fixture for Twin Cylinder

locate the casting centrally in one direction. The swinging clamps *F* are pivoted at one end on the shouldered screws *H*, and they are clamped against the casting by the action of the thumb-screws *G*. The work is centered in the other direction by the steel "bull-center" *T*, which is forced onto the shoulder of the bar *R*. This center is used in the rough cored hole before the clamps have been set up tightly, and while it is in

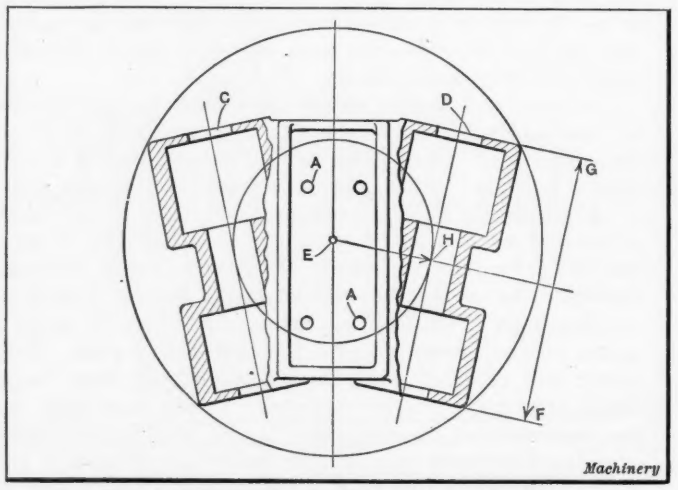

Fig. 9. Roller Bearing Bracket machined with Fixture shown in Fig. 10

position, all screws and clamps are tightened. The pointed set-screws *J* and *K* overcome any tendency of the casting to move during the machining operations. The bearings for the swivel are somewhat out of the ordinary as they are provided with a "take-up" for wear. The hardened and ground steel studs *D* are screwed into place in the swivel and are tapered on their outer ends to form the pivots. The threaded

bushings *P* are milled hexagon on the ends and are tapered on the inside to fit the pivots. Headless set-screws prevent the bushings from turning.

The indexing locations are determined by the bushings *L*, which are forced into the swivel at the three points shown. These bushings are tapered on the inside to fit the pin *N*, which is also encased in the bushing *M*. A coil spring assists in keeping the pin in position. This fixture was not satisfactory due to the overhang of the spindle and a certain tendency to chatter caused partly by the excessive overhang

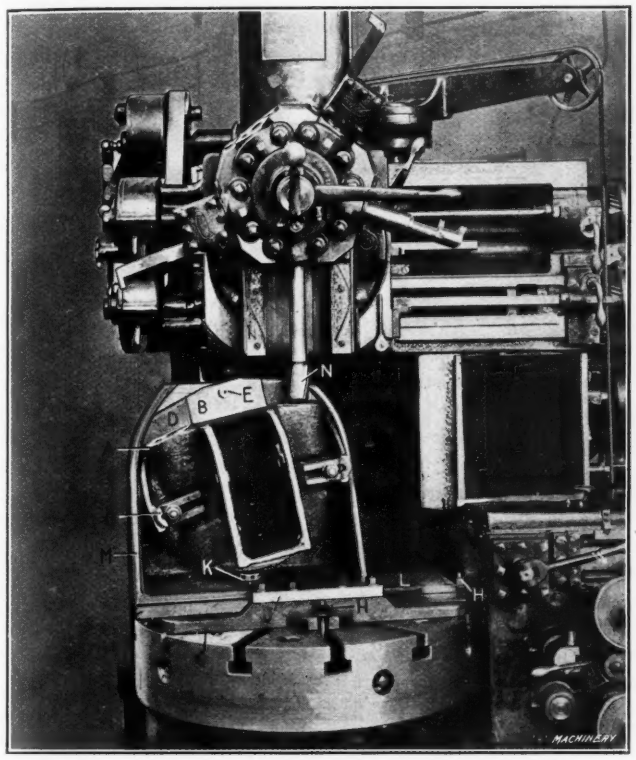

Fig. 10. Bullard Vertical Turret Lathe arranged for machining Roller Bearing Bracket

and partly by imperfect balance when in either of the positions not shown in the illustration. The writer has, however, applied a fixture of very similar construction to a vertical turret lathe with perfectly satisfactory results, showing that the greatest fault was in the excessive overhang when used on the horizontal type of machine. Some of the details of construction in this fixture may, however, be applied to advantage on other work, and it is of considerable value in showing "what not to do," for we really learn more by failures than we do by successes, although a failure may be somewhat expensive.

Indexing Fixtures for the Vertical Turret Lathe

Let us now take up the subject of fixtures which are designed for use on machines of the vertical spindle type. In the majority of cases, it is not necessary to provide counterbalances for this type of fixtures because of the construction of the table bearing which always tends to center itself on account of its conical form. The great weight of the table is also of assistance in overcoming trouble which might be caused by heavy castings of an eccentric or one-sided form. It might be possible to have a manufacturing proposition come up which called for a great number of very heavy eccentric castings of the same kind. In a case of this kind, a counterweight might be used in order to save the machine from excessive strains and unequal wear on the spindle and table bearings. It is not, however, the usual practice to make any provision for counterbalancing.

Indexing Fixture for an Eccentric

A rather peculiar fixture is shown in Fig. 7, this having been made for a vertical turret lathe. The work *A* is of cast iron and is an eccentric strap. In a previous operation this has been turned, faced, and recessed on the flange side, having been held by the solid portion of the body at this setting. The operation of drilling the flange holes in a jig also took place before the setting shown in the illustration. The work for which this fixture was designed is the boring of the eccentric hole, the facing of the top, and the turning of the outside portion. The casting is located by the three pins *E* in the swivel-plate *H* and is clamped down by the three hook-bolts *D*. It will be noted that these hook-bolts are well backed up by bosses on the swivel-plate. The backing is cut away on one side so that the bolt can be swung around when placing a new casting in position. The coil springs underneath assist in releasing. This swivel-plate has the point *N* (shown in the upper view) for its center and swings on the boss *Q*. As point *N* is equidistant from *O* and *P*, it follows that when the swivel-plate is swung around 180 degrees, it will be in the correct position for turning the outside diameter. The three buttons *C* are set in the base *K* and act as clamps on the annular shoulders *J* of the swivel-plate. The base itself is held down to the table by the T-bolts *B*, which enter the table T-slots. It is centered on the table by the plug *M*. The indexing locations are determined by the bushings *F* and *G* in the base. These bushings are tapered to fit a taper spring-pin in the swivel-plate. It will be noted that this method of holding the work made it possible to perform all the turning operations in two settings.

Twin Cylinder Fixture for the Vertical Turret Lathe

The casting shown at *A* in Fig. 8 is a twin cylinder which has previously been machined across the bottom, and in which the flange holes have been jig-drilled. The casting is placed on the sliding plate *F* and is located by the two pins *D* which are diagonally opposite each other. The four clamps *E* are used on the flange to hold the work in position. It will be noticed that the two recesses at *L* permit the boring tools to pass completely through, and provision is made for cleaning out these pockets by sweeping the chips into the two grooves at *O*. Attention is also called to the fact that these pockets are not bored entirely through the slide, for if this were done trouble might be experienced with chips or dirt. The slide is dovetailed on its lower side, as shown in the section *X*—*Y*, and provision is made for take-up by the gib *G*.

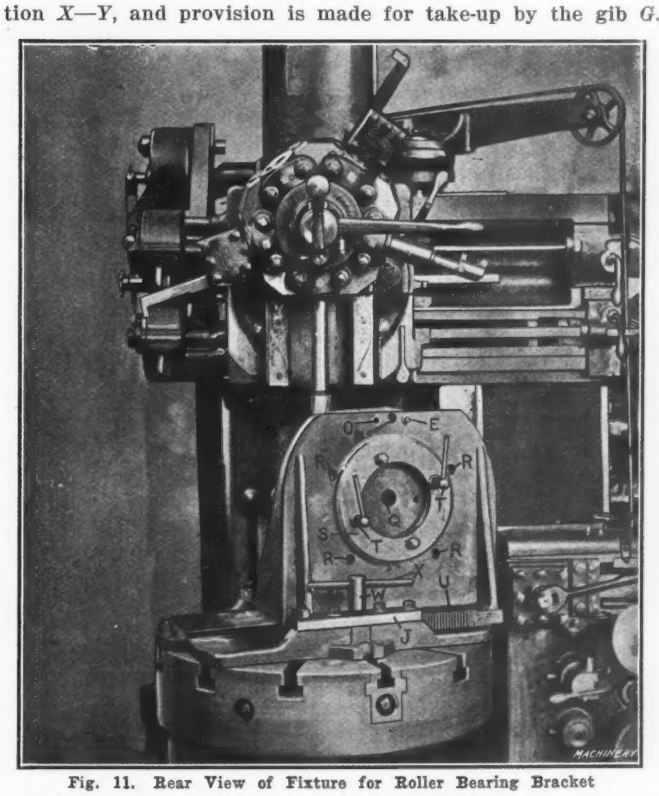

Fig. 11. Rear View of Fixture for Roller Bearing Bracket

The base of the fixture *B* is bolted to the table by the T-bolts *C* and is centered by the stud *M*. The steel strips *H* are so fitted that a sliding fit is insured when the binders *J* are loosened. The indexing is governed by the taper wedge shown at *P* in the upper view. This wedge enters the two slots *Q* and *R* which are tapered to receive it. The pin *S* is used to pull the wedge out of engagement. It will be noted that the view of the work shown in the upper illustration is a section taken on the line *Z*—*Z*, in order to make the construction more apparent.

Indexing Fixture for a Difficult Piece of Work

Fig. 9 shows a partial section of a steel casting which is of considerable size and weighs nearly 300 pounds. It is a tangential roller bearing bracket in which four large pockets are provided to receive the rollers. The center-lines of each pair of pockets *C* and *D* meet at a common center, which is so far outside of the casting proper that it is obviously out of the question to design any sort of fixture for it using this center as the pivot point. Therefore an arbitrary center *E* was used as a pivot for the work, this point being half way between *F* and *G* and on a line perpendicular to the axis of the bearings. It is apparent that the work can readily be swung on this center a sufficient amount to bring the center-lines parallel to the axis of rotation. The back of the casting has been milled off on two parallel pads (not shown in the illustration) and four small holes jig-drilled before the work is placed in the indexing fixture. The two holes *A*, which are engaged by pins on the fixture, are used for locating the casting.

Fig. 10 shows a front view of the vertical turret lathe having the fixture in position on the table. The work *A* is slipped onto the two pins mentioned and is drawn back against the finished surface *B* by the two clamps *C*, which are C-shaped to permit rapid handling. The swivel-plate *D* is of cast iron and has an 8-inch annular ring at the back on which it pivots. This ring is made of generous size in order to give greater rigidity, and also to provide a means of clamping when the work is indexed. The pin *E* is tapered and fits the tool-steel bushings which determine the swivel locations. The sliding portion *M* of the fixture is dovetailed to fit the base *G* and rigidity is secured by gibs *J* in addition to a dovetail gib not shown in the illustration. The screws *H* hold the base down at four points where they enter the table T-slots. Another taper pin shown at *K* is used in obtaining the longitudinal locations. A core drill *N* is shown in position in the turret, and other tools used in machining may also be noted in their respective positions.

Fig. 11 shows a rear view of the fixture; the protruding end of the taper locating pin may be noted at *E*. The other bushing *O* gives the correct location for the other hole in the casting. The two holes *P* and *Q* have nothing to do with the fixture itself, except that they were used by the toolmaker in order to fix his locations more conveniently. A steel clamping ring *S* draws up the swivel-plate tightly after indexing, by means of the two binders *T*. The four holes at *R* give access to hollow cup set-screws in the swivel-plate. These set-screws are brought up against the rough casting to give additional support. A clamping gib on this side of the fixture is provided with a hole through which the squared stem of a twelve pitch pinion protrudes. This pinion meshes with the rack *U* on the slide. The socket wrench *W* fits the squared head of the pinion, and it is provided with a sliding handle *X*. This sliding handle was a necessary feature as several revolutions of the pinion had to be made to obtain the required movement of the slide. As the sliding portion of the fixture with work attached weighed about 800 pounds, it will be seen that some method of traversing the slide was necessary, so that the operator would not be compelled to push it over by hand. This fixture was built for the Bullard vertical turret lathe and its action was very satisfactory.

* * *

THE SOCIETY OF AUTOMOBILE ENGINEERS AND STANDARDIZATION

Howard Marmon, secretary of the Nordyke & Marmon Co. and retiring president of the Society of Automobile Engineers, recently stated that the society is now one of the great engineering bodies of the world. It has a membership of nearly 2000 and is a most vigorous expression of the world's fourth industry. It is, in many ways, a unique organization, but it is not merely an organization—it is a working agency of high efficiency. Every day the work of this society leaves its mark on the American automobile industry. The problems that this body has had to solve were much the same problems, diverse and complex, that faced the railroads and their allied industries in their days of rapid growth. The automobile business brought with it almost innumerable engineering, manufacturing and industrial questions that demanded, and that still demand, quick and skillful consideration.

The modern car has reached its present stage only after a great amount of experimentation. During the past few years the Society of Automobile Engineers has directed this work. What, then, has the society accomplished? Among other things, it has raised the standard of design and effected the standardization of parts. This may not mean much to the average user, but the engineer and the producer know very well how large an undertaking it has been. To standardize an apparently unimportant part often means an amount of labor incomprehensible to the non-mechanical mind. Past construction must be borne in mind, and yet the advance to a new standard of merit must be made. The varying views of engineers must be considered and commercial demands must be regarded, for after all automobiles are made to be sold. Where motor-car companies used to pay eight to ten cents a pound for "double extra special" crankshaft steel they now buy "S. A. E. Specification 10-40" at two or three cents a pound—the same quality in every respect. The engineers of the steel division of the standard committee got together, and using common sense as a text, obtained from the steel makers a commercial price for their wares.

Before the standard committee had formulated its specifications there were 1100 sizes of seamless steel tubing, differing by a few thousandths inch—just enough to make life miserable for the manufacturer. Now the "Data Book" which is rapidly becoming the automobile engineer's bible specifies 160 sizes only. These made up in large quantities come cheaper and delivery is quicker. The result is that the prices of the motor car are less. The owner may now try various carbureters without having his car entirely rebuilt. Gasoline pipe sizes and threads have been made standard, as have the lever connections and the flanges which are joined to the engine or the intake pipe. No longer is a car owner unable to shift from one magneto to another. Again the reason is that magneto bases and connections are now made the same. Wheels for motor trucks have been standardized. They used to vary by small dimensions, and the manufacturer ought to keep in stock four sets of wheels for each truck to meet the varying sizes of tires produced. Now all the tire manufacturers make their tires to conform to S. A. E. standards. Tires are interchangeable on the same wheels. It is estimated that this reform alone has saved $300,000 within the past year.

* * *

INFLUENCE OF VARIOUS METALS ON THE CORRODIBILITY OF IRON

Silicon in iron increases greatly its tendency to corrode; 0.3 per cent of silicon will make iron rust 20 per cent more rapidly than would ordinary iron free from silicon. On the other hand, alloying steel with nickel or copper gives it increased resistance to corrosion; 0.20 per cent of copper in steel produces a material which is attacked by acids at one-tenth the rate of ordinary iron. The corrosion in the atmosphere is only one-third that of iron free from copper. An increase of copper above 0.20 per cent does not add to the corrosion resisting qualities of the iron. These results have been obtained not merely by laboratory experiments, but in practice. Roofs have been covered in and around Pittsburg with ordinary sheet steel and also with a sheet steel containing 0.20 per cent of copper. The copper alloy roofs were in good condition when the ordinary sheet iron roofs were completely corroded. The results of these experiments also showed that the metals are less attacked in rural districts than in cities, this being due probably to the carbon and acid fumes present in the city atmosphere.

* * *

During 1913, 302 people were killed by automobiles in New York City alone. The controlling mechanism of automobiles may have been developed to perfection, but the reckless driver seems beyond control.

ADJUSTABLE CAM-SHAFT AND TIMER DRIVE

BY JOHN L. ALDEN*

The cams and timer contacts of a gasoline engine must bear a precise relationship to the throws of the crankshaft. This means that the error in timing and cam-shaft gear setting must be very slight, and that any angular adjustment, to be of value, must be very close. On motors built in quantities, it is customary to mark the meshing teeth on the crankshaft, cam-shaft, and magneto or timer gears. In this case, no provision is made for changing the timing of the valves and ignition closer than the variation obtained by shifting the meshing gears one tooth either way. When this scheme is used the gears are either keyed to the shaft or bolted fast to a flange.

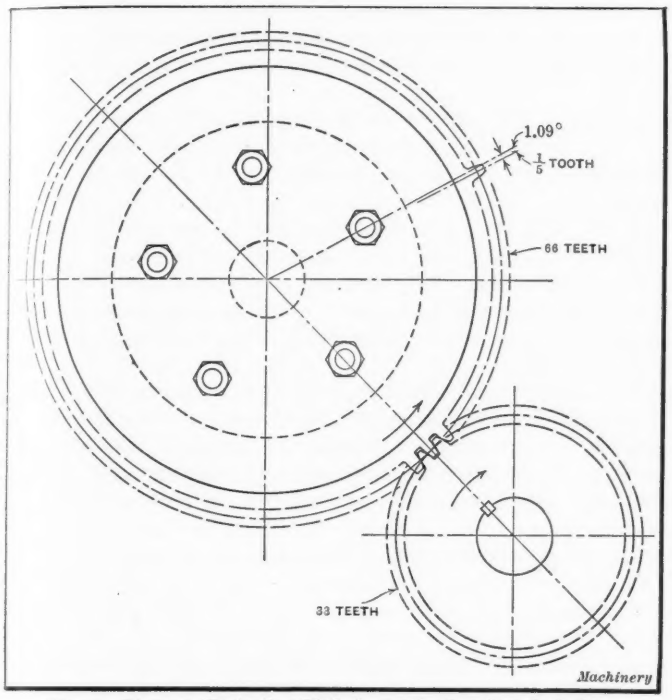

Fig. 1. Diagram illustrating Method of adjusting Cam-shaft Gear with Five Bolt Holes

However, it is frequently desirable to provide means for making finer adjustments than are possible by the method just noted. In fact, this is absolutely necessary in the case of experimental motors, racing motors, and other special machines of this kind. In such installations, means should be provided for shifting the gears with respect to the shaft in steps not greater than 2 degrees each. The most common method in use in this country consists of a gear bolted to a flanged shaft, one member having a greater number of bolt holes than the other. Thus, if two bolts are used, and there are twenty holes in the flange and eighteen in the gear, the closest angular adjustment possible is:

$$a = \frac{360}{18} - \frac{360}{20} = 2 \text{ degrees.}$$

Hence, to be of much value, at least eighteen holes must be used in each member. This makes a rather expensive installation, and is somewhat unsatisfactory in that it does not permit a high degree of precision in gear setting. There are a number of other contrivances in use, most of them, however, employing the slotted hole principle in one form or another. A bolt hole of this kind must be close to size, and, owing to its form, is expensive to machine. Therefore, it is readily seen that none of the devices in common use today are wholly satisfactory, there being some decided drawback in each case.

It is the intention of this article to present an improved adjustment which is not, to the writer's knowledge, common property in the American automobile and machinery field. This design is being employed with considerable success abroad, and it is hoped that the idea may be of service to designers on this side of the Atlantic. Like the methods previously described, this design requires a flanged shaft, drilled with a number of bolt holes exactly in register with corresponding holes in the gear. The holes in the latter must, of course, be located accurately with respect to certain teeth. The adjustment of the gear depends entirely upon the fact that the number of bolt holes is not an even divisor of the number of teeth. The relation between the number of teeth and the number of holes is most simply expressed by the formula:

$$N = k\,n + r.$$

$$\frac{N}{n} = k + \frac{r}{n} \qquad (1)$$

where N = number of teeth in gear;

n = number of bolt holes;

k = integral part of quotient obtained by dividing N by n;

$\frac{r}{n}$ = fractional part of quotient obtained by dividing N by n.

The angular adjustment, expressed in degrees, is represented by:

$$a = \frac{360\,r}{N\,n} \qquad (2)$$

The method of making this adjustment is very simple. When the setting has been made to within one tooth of the desired point, the operator should ascertain whether the valves have lag or lead. For the sake of illustration, assume that the valves have a slight lead. The gear is then removed from the flange and turned backward against the direction of rotation, one or more holes, the shaft being held stationary. After remeshing the teeth, the cam-shaft gear is again fastened to the flange thereby completing the operation. In case the valves lag, the gear should, of course, be turned ahead. To make the matter clearer, let us consider a numerical example taken in connection with Fig. 1.

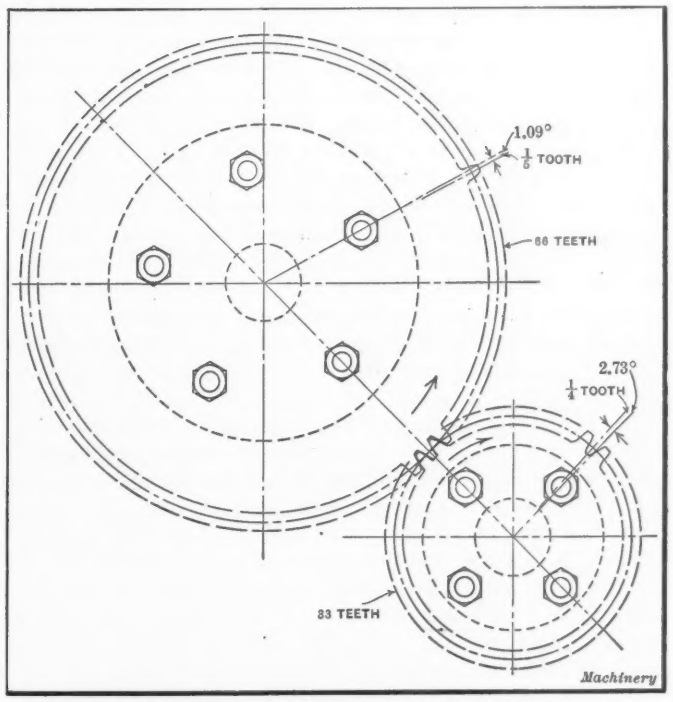

Fig. 2. Bolt Holes in both Cam-shaft and Crankshaft Gears to provide for Finer Adjustment than can be made with Arrangement shown in Fig. 1

It is required to find the finest angular adjustment which can be given to a cam-shaft whose gear has sixty-six teeth and five bolt holes. From Equation (1):

$$\frac{66}{5} = 13 + \frac{1}{5}.$$

Hence $k = 13$ and $\frac{r}{n} = \frac{1}{5}$.

From Equation (2) the angular adjustment is:

$$a = \frac{360}{66} \times \frac{1}{5} = 1.09 \text{ degree.}$$

In case even closer regulation is required, the driving gear

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—in this instance the crankshaft gear—may be provided with precisely the same type of adjusting device. If this is done, the angular adjustment becomes:

$$a = \frac{1}{2} \times \frac{360\, r_1}{N_1 n_1} - \frac{360\, r}{N\, n} \qquad (3)$$

where N_1, n_1, and r_1 are the corresponding values of N, n and r for the driving gear on the crankshaft. Thus for the example shown in Fig. 2 the possible adjustment is:

$$\frac{1}{2} \times \frac{360 \times 1}{33 \times 4} - \frac{360 \times 1}{66 \times 5} = 0.275 \text{ degree.}$$

This provides an adjustment which is delicate enough for any ordinary purpose, and has the additional advantage of being relatively inexpensive. It will, of course, be understood that it is only the fractional part of a tooth, $\frac{r}{n}$, that affects the adjustment, as the movement of a whole number of teeth k does not affect the relative positions of the shafts when the gears are remeshed after making the adjustment.

* * *

CHARACTER OF PAPERS TO BE READ AT THE ENGINEERING CONGRESS

In the December number of MACHINERY mention was made of the International Engineering Congress which will be held September 20 to 25, 1915, in connection with the Panama-Pacific Exposition in San Francisco. This congress is conducted under the auspices of the great national engineering societies in the United States. The character of the papers that will be read will be of especial interest. As a general rule, it is intended that each paper shall treat its assigned topic in a broad and comprehensive manner and with special reference to the important lines of progress during the past decade, the present most approved practices, and the lines of present and future development. It is intended, furthermore, that all such papers shall be accompanied with a reasonably full bibliography of the subject, giving reference to the important original papers and sources of information relating to the special topic of the paper. In this manner the reader will be furnished with a rapid and comprehensive review of the recent important work relating to such topic, together with references to individual papers and sources of information for more complete and minor details. Papers of this type, rather than those which deal with individual constructions or special and individual problems or investigations, will generally serve the purpose of an engineering congress better. Papers of the latter type will naturally find their place in the proceedings of the regular sessions of the various engineering societies, while the occasion of a great engineering congress furnishes a more appropriate opportunity for papers of the broad survey or encyclopedic type.

An important exception to this general plan, however, will be found in a series of papers relating to the Panama Canal, of which it is intended to make a special feature of the congress. These papers will deal with the engineering of the Panama Canal in all its branches, with the influence of the canal on world commerce, commercial trade routes and general transportation problems. Colonel Goethals has promised his aid in securing this series of papers, which will thus form a definite and authoritative discussion of the engineering problems involved in this great undertaking.

In other special fields it may be found desirable to depart somewhat from the character of the papers outlined above, but, in general, and aside from those relating to the Panama Canal, the papers will be of the character indicated. In order to realize these various purposes with regard to the papers and especially to avoid either the overlapping of two or more, or the omission of some important topic, the Committee on Papers is now preparing a carefully considered list of topics to be treated in the various branches of engineering, together with a general syllabus or outline of the specific ground to be covered by each paper, and to which each contributor will be asked to adhere as closely as practicable.

PROPERTY RIGHTS IN ENGINEERING DRAWINGS AND DATA

In an address before the student branch of the American Society of Mechanical Engineers, at Cornell University, Prof. Frederick R. Hutton touched upon the subject of the relations of the draftsman and engineer as regards his proprietary right in the designs which he creates. This question is closely allied with that of ownership of patents which originate during the work carried out by the draftsman. The subject was divided into four principal questions, as follows:

1. May a draftsman make blueprints from his own drawings embodying his own computations, and take these home with him or away with him when he leaves his job? May he do this with the drawings of his fellow workers? These will enhance his value to any subsequent employer. Are they *his?*

2. Suppose he bought his own paper, and did his printing at home on Sundays and holidays, so that his records were not made at his employer's expense? Does this change anything?

3. Suppose that this same information, tables of sizes and proportions, design data and standards, are in note-books, may the draftsmen copy these, and carry such priceless information gathered through years of wage-paying and experiment with him to his next place, and perhaps to a competitive concern?

4. Can an improvement in a process, or a new process or an improved design, or a new mechanical movement be patented by the draftsman for himself, while he is working for an employer on a similar problem, and be used to hold up his employer until the parties can agree as to the terms of use or sale?

The accepted answer, emphasized by decisions of Court, and embodied in codes and standards of professional ethics, is that drawings and data belong to the employer, and the engineer or draftsman may not take them away with him. The reasons back of this practice include: 1. The shop furnished the plant—rent, heat, light, tools, etc.—where these ideas were conceived. 2. The shop presented the problem—without this the invention or the design would never have been created. 3. The shop furnished antecedent knowledge and acquired experience, which molded the creation, and prevented mistakes and waste. 4. The shop furnished experimentation, actual or precedent, which gave the creation its practical or commercial shape. 5. For many creations, the shop furnished or will furnish the manufacturing facilities which the inventor would otherwise have to struggle to find or pay for heavily elsewhere. 6. For many creations, the shop furnishes the selling or marketing facilities of its commercial organization.

Again, the draftsman or engineer may contract by a signed instrument to give shop or manufacturing rights to the employing shop, while retaining the right to sell or license to outside parties. Or, again, this principle may be made applicable to patents which relate to the employer's business, while patents in no way related thereto may be expressly excluded, and the employer stands as an outsider would, in relation to purchase or license.

Closely interwoven with this matter is the "trade-secret" problem. Here the employer confides to his engineer or draftsman or other employe knowledge of immense commercial importance to him, and which for many practical reasons he cannot protect by the procedure of the patent. The European practice has some vogue where the engineer and draftsman agree by signed instrument not to enter another concern in the same line of production for five years after leaving his confidential relation. Five years will render much of his inside knowledge obsolete; and the first concern will not suffer from a breathless and panting chase of another five years behind it. Many of these contracts have, however, been declared void by the Courts in the United States.

* * *

Fine spun theoretical knowledge, unless mated with horse sense, breeds frills and gewgaws in design and causes waste of effort and money.—*Journal Worcester Polytechnic Institute.*

HEAVY-DUTY SHAFTS WITH TWO AND THREE BEARINGS

AN INVESTIGATION OF SHAFT DESIGN WITH TWO AND THREE POINTS OF SUPPORT

BY W. G. DUNKLEY*

Many cases arise in machine tool design in which one or more gears have to be placed near the middle of a shaft owing to the location of other gears. In such cases, the shaft may either be designed to carry the load when it is supported in two end bearings or a third bearing may be provided at the middle. The latter method of procedure is coming into very general use. The purpose of this article is to investigate the design of a shaft under both these conditions and discuss the various points which arise when three bearings are used instead of two.

Fig. 1 illustrates the conditions which have been assumed for the purpose of discussion. In this illustration, W_1 is the driven wheel and W_2 the following driver, the shaft between these wheels transmitting the torque. The calculations are based on the assumption that the wheels are capable of transmitting the full horsepower of the motor when running at their lowest speed. The tangential tooth loads are 5 tons on wheel W_1 and 7.5 tons on wheel W_2; the torque on the shaft is $5 \times 19 = 95$ inch-tons. The bending moment on the shaft will approximate its maximum value when the shaft centers lie in a straight line as shown in Fig. 2, *i. e.*, when the lines of action of the tangential tooth loads are parallel. The dotted arrows in Fig. 2 show the actual directions in which the tooth loads act if the obliquity of action is taken into account. Strictly speaking, it will be seen that the greatest possible bending moment on the shaft S_2 will be produced when the lines of centers S_1 and S_2 and S_2 and S_3 are each inclined at an angle of 14½ degrees to the horizontal. With lines of

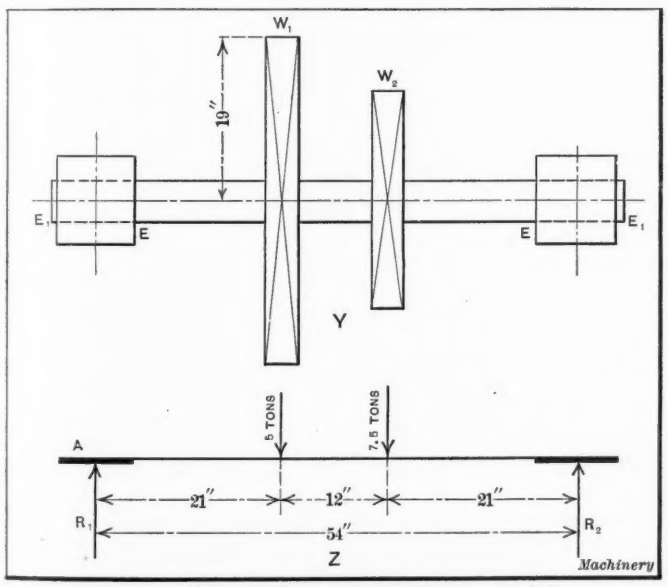

Fig. 1. Diagrams illustrating Conditions assumed for Discussion of Shaft supported by Two Bearings

contact inclined in this way the dotted arrows representing the actual direction of the pressure on the teeth would be parallel.

Shaft Carried in Two Bearings

To obtain the maximum bending moment it is assumed that the shaft is simply supported at the middle of each end bearing as shown at *Z* in Fig. 1. For this to be the case, it would mean that the reactions at the bearings are evenly distributed over the entire bearing surface. This point will be referred to in detail in a later paragraph. By taking moments about *A*, we have:

$$54\,R_2 = 5 \times 21 + 7.5 \times 33$$

$$R_2 = \frac{352.5}{54} = 6.5 \text{ tons}$$

$$R_1 = 12.5 - 6.5 = 6 \text{ tons}$$

The maximum bending moment M will occur under the 7.5-ton load.

$$M = 6.5 \times 21 = 136.5 \text{ inch-tons}$$

$$T = 95 \text{ inch-tons}$$

The diameter of the shaft that is required for carrying this combined bending and twisting load can be quickly obtained from the charts which were published in connection with an

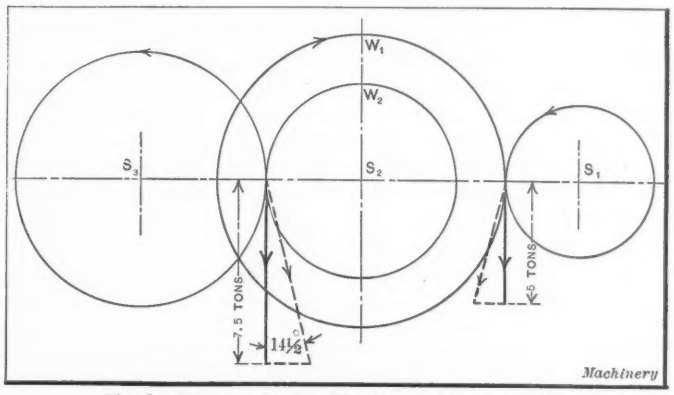

Fig. 2. Diagram showing Direction of Lines of Action of Pressures on Gear Teeth

article by the present writer that appeared in the August, 1913, number of MACHINERY. Using the chart, the value of the shaft diameter is found to be 7.5 inches. If the charts are not available, the result may easily be obtained by calculation. Denote the twisting moment that is equivalent to the combined bending and twisting moments acting on the shaft by T_1.

$$T_1 = M + \sqrt{M^2 + T^2} = 136.5 + \sqrt{136.5^2 + 95^2} = 302 \text{ inch-tons.}$$

The required diameter D of the shaft is obtained from the following equation:

$$D^3 = \frac{16\,T_1}{\pi f}$$

where

f = safe fiber stress = 3.5 tons per square inch;

$$D^3 = \frac{16 \times 302}{3.1416 \times 3.5} = 439;$$

$D = 7.5$ inches (approximately).

The next point is to make sure that the deflection of the shaft due to the load is not excessive. For the given arrangement of the loading the most convenient method of obtaining the deflection would be by graphical analysis. This amount of work is hardly necessary in the present case, however, as a sufficiently accurate idea of the deflection can be obtained by regarding the loads as concentrated at the middle of the shaft. For this condition, the deflection d is given by the following equation:

$$d = \frac{WL^3}{48\,EI}$$

where

$$I = \text{moment of inertia} = \frac{\pi D^4}{64} = 156;$$

W = load on shaft = 12.5 tons;

L = length of shaft = 54 inches;

E = modulus of elasticity = 13,000 tons.

Then

$$d = \frac{12.5 \times 54^3}{48 \times 13{,}000 \times 156} = 0.0202 \text{ inch.}$$

The actual deflection will be slightly less than the preceding value because the loads are not actually concentrated at the center of the shaft in the way that was assumed to facilitate calculation. Consequently, a shaft rather smaller than 7.5 inches in diameter might be used with safety.

If, instead of acting in parallel directions, the loads on the shaft are inclined in the directions of the arrows indicated at *X* in Fig. 3, the maximum bending moment is obtained as follows: The inclined load W_2 is resolved into components $W_2 \sin \theta$ acting vertically and $W_2 \cos \theta$ acting horizontally.

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At Y is shown the arrangement of the vertical load W_1 and the vertical component of the load W_2; at Z, the arrangement of the horizontal component of W_2 is shown. Call F and F_1 the reactions due to the vertical loads shown at Y, and P and P_1 the reactions due to the horizontal load shown at Z. Then there will be one bending moment $M_1 = F_1 \times 21$ which acts under the load W_2 and also a second bending moment $M_2 = P_1 \times 21$ acting under the load W_2 at right angles to the first bending moment. The resulting bending moment M under the load W_2 is then obtained by the following equation:

$$M = \sqrt{M_1^2 + M_2^2} \qquad (1)$$

Similarly there are two bending moments acting at right angles to each other under the load W_1 which have values given by the following:

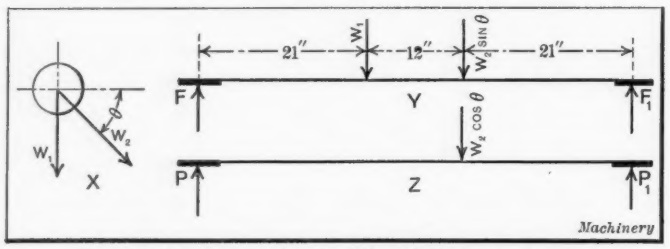

Fig. 3. Diagrams showing Condition of Shaft carrying One Vertical and One Inclined Load

$$M_3 = F \times 21 \quad \text{and} \quad M_4 = P \times 21$$

The resultant of these bending moments is given by the following:

$$M = \sqrt{M_3^2 + M_4^2} \qquad (2)$$

The maximum bending moment M is obtained from either Equation (1) or (2), the bending moment being the result of the equation which gives the greatest value. This result is then used with the twisting moment in order to obtain the required diameter of the shaft by the method of calculation previously explained.

To return to the question of the pressures being evenly distributed over the bearings of the shaft shown in Fig. 1: When the loads are first applied on the shaft the resulting deflection will tend to lift the ends E_1 off the bearing, thus concentrating the full bearing load at a point nearer the inner ends E of the bearings. As a result, the bearings will wear at the points where the load is greatest and this wear will tend to continue until it reaches a point where the pressure is evenly distributed. When this condition is reached, any wear which develops in the bearings will be uniformly distributed. If, however, the deflection of the shaft is of considerable magnitude, the condition indicated in Fig. 4 may be produced, *i. e.*, the ends E_1 of the shaft may be raised sufficiently to induce downward pressures L_1 and L_2. The total downward pressure will then be the loads on the shaft plus these induced loads L_1 and L_2, and this pressure will be concentrated at the points E. .This condition will obviously tend

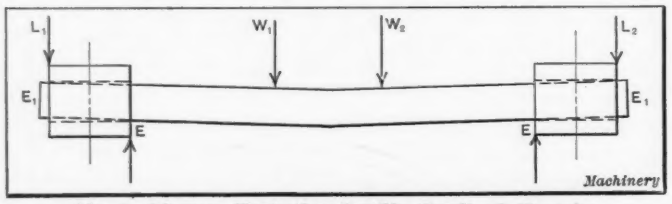

Fig. 4. Diagram illustrating Possible Result of Excessive Deflection of Shaft

to cause trouble in the bearings and such trouble may be experienced by having the shaft too weak, even though the load is not excessive or the design of the bearings defective in any way. Considering the large diameter that was found to be necessary from the preceding calculations, it is not surprising that it is becoming a general practice to support such a shaft on three bearings as shown at X in Fig. 5.

Shaft Carried in Three Bearings

In order to investigate the conditions of a shaft supported by three bearings, it will be necessary to not only obtain the required diameter of the shaft but also to investigate the distribution of the total load over the three bearings. The latter will be found to constitute an extremely important factor. The first step is to obtain the maximum bending moment on the shaft. Regarding the spans AC and CB as simple beams supported at the ends and loaded with 5 and 7½ tons, respectively, the negative bending moment diagrams are as illustrated at Y in Fig. 5. For the simple beam AC let R_a equal the reaction at A.

Then

$$R_a \times 27 = 5 \times 6$$

$$R_a = \frac{30}{27}$$

The maximum bending moment M is given by the following:

$$M = R_a \times 21 = \frac{30}{27} \times 21 = 23.3 \text{ inch-tons}$$

The ordinate DD_1 in the negative bending moment diagram is therefore made to represent 23.3 inch-tons. By a similar method of procedure it will be found that the maximum bending moment on the beam CB is 35 inch-tons and the ordinate EE_1 is laid off to represent this value.

The positive bending moment diagram is next superimposed upon the negative bending moment diagram. For the present, the value of the positive bending moment at the middle support is unknown. The positive bending moment is obtained from the equation deduced from the theorem of three moments given by the following:

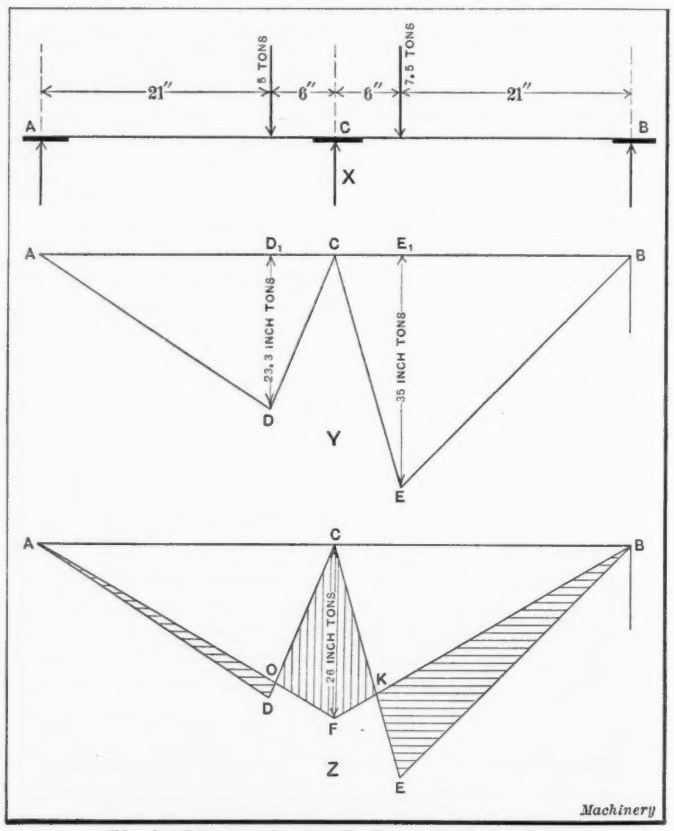

Fig. 5. Diagram showing Shaft supported by Three Bearings and Bending Moment Diagrams

$$\frac{6Z}{L_1} + \frac{6Z_1}{L_2} = M_a L_1 + 2M_c (L_1 + L_2) + M_b L_2$$

where

Z = moment about A of the negative bending moment diagram for the span AC, *i. e.*, the moment of the triangle ADC about A;

Z_1 = moment of triangle CEB about end B;

M_a = positive bending moment at support A; the value of this moment is zero in the present case since the ends are simply supported.

M_b = positive bending moment at B = zero for the present case;

M_c = positive bending moment at C = ordinate CF;

L_1 = length of span AC = 27 inches;

L_2 = length of span CB = 27 inches.

For the present case the equation derived from the theorem of three moments reduces to:

$$6(Z + Z_1) = 4 \times 27^2 \times M_c \qquad (3)$$

Since

$L_1 = L_2 = 27$ and $M_a = M_b = 0$

$$Z = \frac{23.3 \times 21}{2} \times \frac{2}{3} \times 21 + \frac{23.3 \times 6}{2}\left(21 + \frac{6}{3}\right) = \text{moment of } ADD_1 + \text{moment of } D_1DC \text{ about the end } A.$$

$Z = 23.3 \times 147 + 23.3 \times 69 = 23.3 \times 216 = 5032.$

Similarly $Z_1 = 35 \times 216 = 7560.$

Substituting the preceding values of Z and Z_1 in Equation (3) gives

$$6\,(5032 + 7560) = 4 \times 27^3 \times M_c$$

$$M_c = \frac{6 \times 12{,}592}{4 \times 27^3} = 26 \text{ inch-tons}$$

Making the ordinate $CF = 26$ inch-tons, the triangle AFB, shown at Z in Fig. 5, represents the positive bending moment diagram which is to be superimposed on the diagrams of negative bending moments shown at Y. The shaded portions of the diagram show the resultant bending moment diagrams. The triangles ODA and KEB are the negative bending moment diagrams and the area $OCKF$ is the positive bending moment diagram. Consequently the maximum bending moment M occurs at the point C and has a value of 26 inch-tons. The twisting moment T has a value of 95 inch-tons, as previously determined. For this combined twisting and bending load the required shaft diameter is obtained from the chart or by means of the formula previously given, and is found to be 5.75 inches. This figure is based upon an allowable fiber stress of 3.5 tons per square inch.

Distribution of the Load on the Bearings

Let R_a represent the reaction at the bearing A (Fig. 5). Taking moments about the point C of all loads to the left of C gives $5 \times 6 - R_a \times 27 =$ positive bending moment at $C = 26$ inch-tons.

$$R_a = \frac{4}{27} = 0.148 \text{ ton.}$$

Taking moments about the point C for all loads to the right of C gives $7.5 \times 6 - R_b \times 27 = 26$ inch-tons.

$$R_b = \frac{19}{27} = 0.7 \text{ ton}$$

From the preceding we obtain

$$R_c = 12.5 - R_a - R_b = 11.6 \text{ tons.}$$

It will, of course, be evident that the reaction of R_c represents the load on the middle bearing, from which it will be seen that by far the greater portion of the load is carried at this point and it is extremely important for this fact to be remembered when determining the dimensions of the middle bearing. In the case of the shaft carried by two end bearings, the most important factor was the deflection, and as it is obvious that the provision of a central bearing will materially reduce this deflection, the necessity for providing a large central bearing may easily be overlooked. If this mistake is made, the provision of the central bearing may actually do more harm than good. Although the end bearings A and B in Fig. 5 take only a small part of the load for the conditions shown in the illustration, it must not be forgotten that the maximum loads on the end bearings probably occur when other gears on the shaft are carrying the load. The fact that the load is distributed over the middle bearing will make the shaft slightly stronger than it was found to be by the preceding calculations.

Finally, it is desirable to examine the torsional stiffness of the shaft, particularly for cases where the gears have to slide on keys. For the case under consideration, where the twisting moment $T = 95$ inch-tons, let

$L =$ the length in inches of shaft carrying the torque;

$N =$ modulus of rigidity $= 5000$ tons;

$\theta =$ angle of twist in degrees.

Then

$$\theta = \frac{583\,LT}{ND^4}$$

Assuming that under certain circumstances the whole length of the shaft is under torque, *i.e.*, $L = 54$ inches

$$\theta = \frac{583 \times 54 \times 95}{5000 \times 5.75^4} = 0.55 \text{ degree, approximately.}$$

The value obtained by the preceding equation is, of course, an extreme case which would seldom arise in actual practice, but calculating on this basis insures having a shaft of ample strength.

* * *

PIECE-WORK AND PROGRESS

BY J. CROW TAYLOR*

Perhaps the strongest point that can be raised by manufacturers and shop superintendents against piece-work is that it often proves a handicap to progress. Piece-work primarily makes for higher efficiency with the equipment and the men at hand. It encourages effort and makes its return in proportion to the amount of effective effort put forth.

The trouble comes when new improvements are offered in the way of machines and equipment to reduce cost. Here the piece-work system stands as a bar that sometimes may be let down easily and sometimes may not. There is always more hesitancy about installing labor-saving machines and devices where the piece-work system is in vogue than where day-work prevails, because, if for no other reason, it calls for a readjustment of piece-work prices. This is always a difficult and trying problem—one that too often results in dissatisfaction and labor troubles.

An illustrative instance of this kind was given by a factory owner recently in connection with their molding department. As any one familiar with molding knows cutting the sand is one of the unliked and tiresome jobs connected with the work. This man said that there was brought to him a proposition in the shape of a mechanical device that would do the work of cutting the sand for the molders in his place for less than half what it was costing him. Most of them were shirking this task themselves by letting it out to others on a contract basis. The man with the mechanical device would not offer to sell his device outright, but wanted to operate it on a contract basis. This involved more complications than would have been met with had the proposition been for the owner to buy the equipment and readjust his molding scale accordingly. The proposition involved giving the molders the benefit of the saving effected, yet a share of it must needs go to the factory owner, too, because some power was required to drive it and the power would have to be supplied by the factory. He said that he had been trying for some time to figure out a scheme by which they could use it because it could easily effect a saving for them and at the same time help the molders to make more money.

He will perhaps find a way somehow, some day, but the incident serves to illustrate how piece-work is often a handicap to progress, not necessarily because the piece-workers are opposed to innovations and labor-saving devices, but because any new thing of this kind calls for an entire reorganization of the system. This is troublesome and results in grumbling and dissatisfaction, and the upshot of it all is that many factory owners operating on the piece-work basis let opportunities to improve their plant in efficiency go by because of the handicap of piece-work.

Perhaps in a general readjustment of industrial affairs between employers and employes there will be devised some scheme for a satisfactory day wage regulation supplemented with a profit-sharing proposition that will be satisfactory all around. Then progress in the way of efficiency through new machines and appliances and methods will be made easy and freed from some of the handicaps that seriously retard it today.

* * *

Iridium was once cheaper than platinum, but at present its value is about twice that of the latter metal. Up to a few years ago, there was no other use for it except for the points of gold pens, but since then it has found extensive use as a hardener for platinum. Very little pure platinum is now being used and nearly all of the commercial metal going under this name is the so-called "hard" platinum which is an alloy of platinum and iridium.

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THE ACCURATE HEAT-TREATMENT OF ROLLER BEARING PARTS*

EQUIPMENTS AND METHODS WHICH FACILITATE RAPIDITY IN HANDLING AND UNIFORMITY OF WORK

BY E. F. LAKE†

The manufacture of bearings of either the ball or roller type has grown into a good sized industry in the past few years. The automobile industry is responsible for a large part of this growth, as it would have been difficult, if not impossible, to make the automobile a success without these anti-friction bearings. This is especially true of roller bearings, which are used on nearly all automobile wheels and are a special benefit. They must be made as small and light as possible and, at the same time, strong enough to carry the load of the car, combined with that of the passengers or other weight that the car may carry.

The first essential of either type of bearing is a steel that possesses the qualities that will enable it to withstand the strains to which the bearings may be subjected. The second essential is correct machining operations, as the parts must be made within a fraction of a thousandth of an inch of the correct size. The third essential—and perhaps the most important one—is the heat-treatment that these parts receive. This must be of such a nature as to make the steel resist the crushing, vibrational, frictional, or other strains to which all bearings are submitted. The reason this is considered the most important factor in the process of manufacture is that the strength, wearing qualities, resistance to fatigue, etc., can be greatly increased or decreased by accurate or inaccurate heat-treatment. It is an easy matter to accurately heat-treat ordinary carbon steels and make them excel the highest grades of alloy steels which are not correctly heat-treated. At the same time, it is possible to give such alloy steels double the elastic limit and reduction of area of the ordinary carbon steels when both are correctly heat-treated. Likewise, the resistance to fatigue, or vibrational strains, of the alloy steels can be made more than quadruple that of the carbon steels.

After the steel parts of bearings have been machined to their correct size and shape, it is essential that they be thoroughly annealed before they are carbonized, hardened and tempered, or subjected to both these treatments. This relieves any internal strains, making the physical properties the same in all parts of a piece and the strength uniform in all directions from any given point. For this reason the annealing of all other steel parts is just as essential, and particularly those parts that have to resist strains of any kind. It should always be remembered that a steel piece is greatly weakened when more of the cohesive force, which binds the molecules together, is concentrated at one place than at another. When steel leaves the rolling mill it is full of these unequal strains.

Fig. 1. Casehardening Pots and Special Heating Furnaces used by the Timken Roller Bearing Co.

All steels that are used in the manufacture of ball and roller bearings are first poured into ingots that may be anywhere from 6 to 18 inches square. These ingots are usually hammered to a size that will make them small enough for the rolling or forging operations. The grain of the cast ingots is very crystalline and, hence, very weak in comparison with the same steel after it has been hammered, rolled, forged, etc. The mechanical working crushes the crystals together and gives the metal a more fine and dense structure. It increases the elastic limit and other static properties of the metal, as well as its dynamic properties.

While doing this, however, it sets up unequal internal strains in the steel which should be removed before attempting to give it its final heat-treatment. Therefore, the various parts that enter into the construction of the complete

* For other articles on the heat-treatment of steel published in MACHINERY, see "The Heat-treatment of Gears at the Boston Gear Works" by George L. Colburn, published in MACHINERY, June, 1913, and other articles there referred to.

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bearings of the best grades are always thoroughly annealed just before they are carbonized, or hardened and tempered. Sometimes steel is annealed before any machine work is performed. This first annealing is usually done at the steel mill before the steel is shipped, but it will not take the place of the annealing that should be done after the steel is manufactured into the different pieces. This is because the machining operations are likely to set up other internal strains.

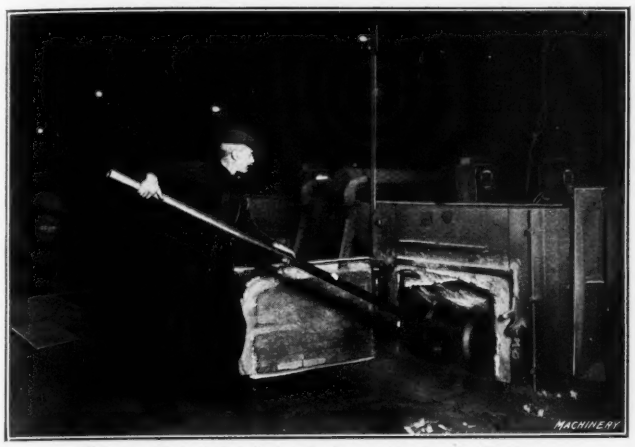


Fig. 2. Use of Truck in placing a Pot in the Furnace

In heating steel, the temperature will reach a point at which there occurs a change in the grain, or a new grain structure is born. With this rearrangement of the grain structure any unequal strains will disappear. Annealing consists of raising the temperature of the steel high enough to be assured that the metal has had time to thoroughly complete this change of structure. The steel is then allowed to gradually cool to the temperature of the atmosphere. The slower this cooling takes place the more thorough will be the annealing and the obliteration of any internal strains. If cooled too quickly, a hardening of the metal takes place and other strains are likely to be set up; this is especially true if it cools unevenly or more quickly in some sections than in others. If the steel is heated too high above the transformation point the grain will become coarsened, as each degree of temperature above this point adds to the coarseness of the grain structure.

This information is the basis of three rules that it is well to follow when annealing all steels. First, heat the metal to a temperature above the highest transformation point but not far enough above to coarsen the grain; second, hold the temperature at this point long enough to allow the transformation to be completed but do not prolong it beyond that; third, make sure that the rate of cooling is sufficiently slow to prevent even a superficial hardening.

To insure a uniform heating in a neutral atmosphere and a slow cooling, small parts should be packed in some non-carbonizing material held in metal pots, the covers of which are sealed on with clay before the pots are put into the furnace to be heated up to the annealing temperature. The Timken Roller Bearing Co., of Canton, Ohio, probably handles this work as economically as it is possible to and still obtain the accuracy that is required. The method of procedure is shown in Fig. 1. Round cast-iron pots with hollow centers are used,

Fig. 4. Dumping and sorting Work that has been carbonized

in which the work is packed in the non-carbonizing material. When the pots are filled, they are lifted by the two-wheeled truck shown to the right and wheeled into the furnace, as shown in Fig. 2. Then the pot is dropped on its four legs, the truck pulled out and the door closed.

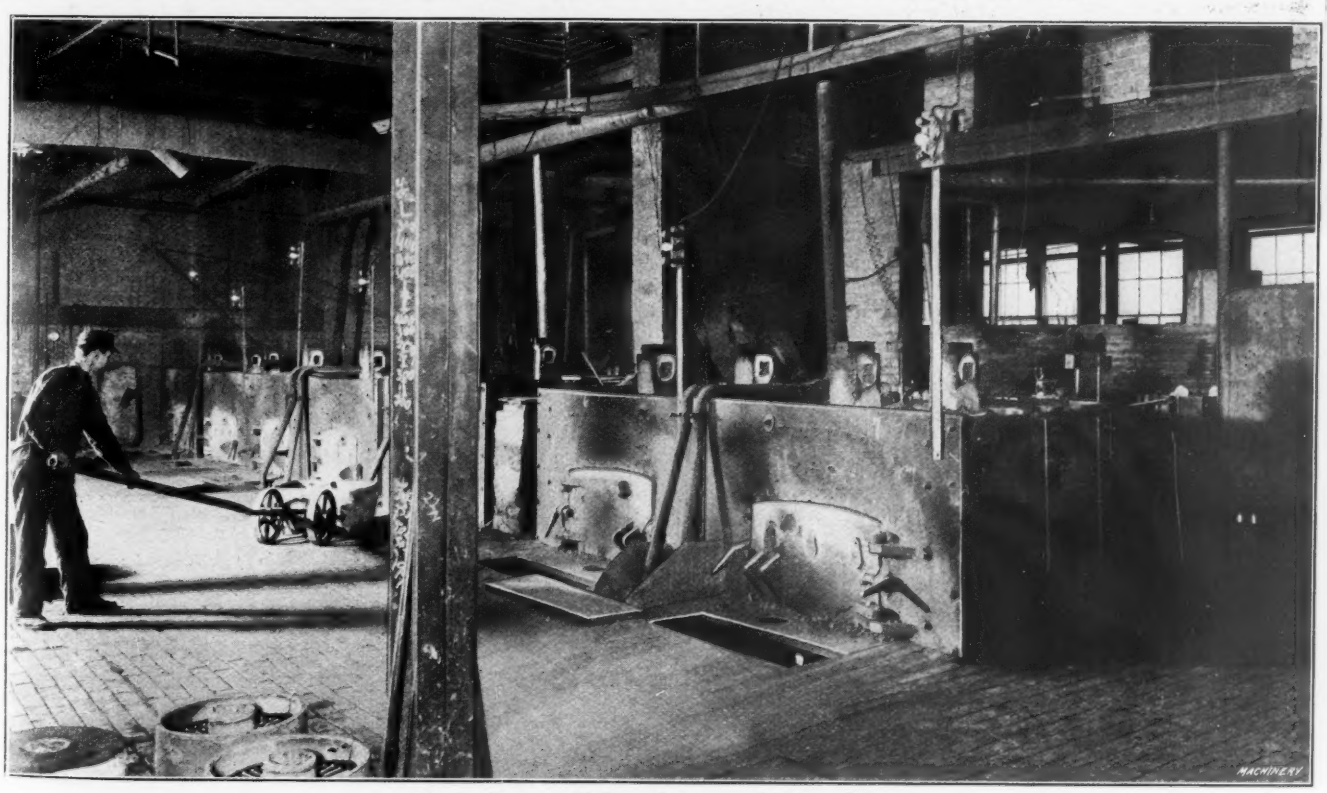


Fig. 3. Furnace with Floor-plate removed to show Burner

The oven of each furnace has been lowered so that its bottom is level with the shop floor, and thus a great deal of time and labor is saved in charging the work into the furnaces. In front of each furnace there is a pit covered with floor plates. The burners, piping and valves that convey and regulate the fuel and blast which supplies the furnaces with

heat are located in these pits, the combustion chambers of the furnaces being below the floor level. The burner in the first furnace is clearly shown in Fig. 3, by the white spot under the door of the heating chamber, the floor plate having been removed for this purpose. These furnaces were built by the company from their own special designs, with a view of obtaining accuracy and uniformity of temperature in the heating chambers. They are built in pairs.

Before adopting this method the pots were gripped with long tongs by one man, and two other men, one on each side of the furnace door, lifted each pot into the furnace or took it out, the furnaces being set on top of the floor, as is the usual custom. By lowering the combustion chamber below the floor level and thus bringing the floor of the heating chamber on a level with the shop floor, one man with the truck shown in Figs. 1 and 2 is able to handle larger and heavier pots in less time than that formerly taken by the three men. Thus, the saving in labor has more than paid for the lowering of the furnaces.

white light burning. If the temperature goes too high, this central light is turned off and the red one above it is lighted. Then the furnace operator must lower the fuel oil and blast that is going through the burners and thus reduce the size of the flame. When the temperature is too low, the blue light is turned on and the others are switched off. Then it becomes necessary to increase the column of the flame entering the furnace.

Fuel oil and dry steam are used for heating the furnaces. This oil is located in large tanks underneath the floor of the shop and quite a distance away from the furnaces. As pressure on the oil is needed, a pump drives the oil from this tank through the burners at a pressure of about 15 pounds per square inch. The steam passes through the burners at a pressure of about 60 pounds per square inch and this gives the proper combustion.

Some parts of bearings withstand the strain much better if made from low carbon steel and carbonized. This gives the outer surfaces of such parts a high carbon content that

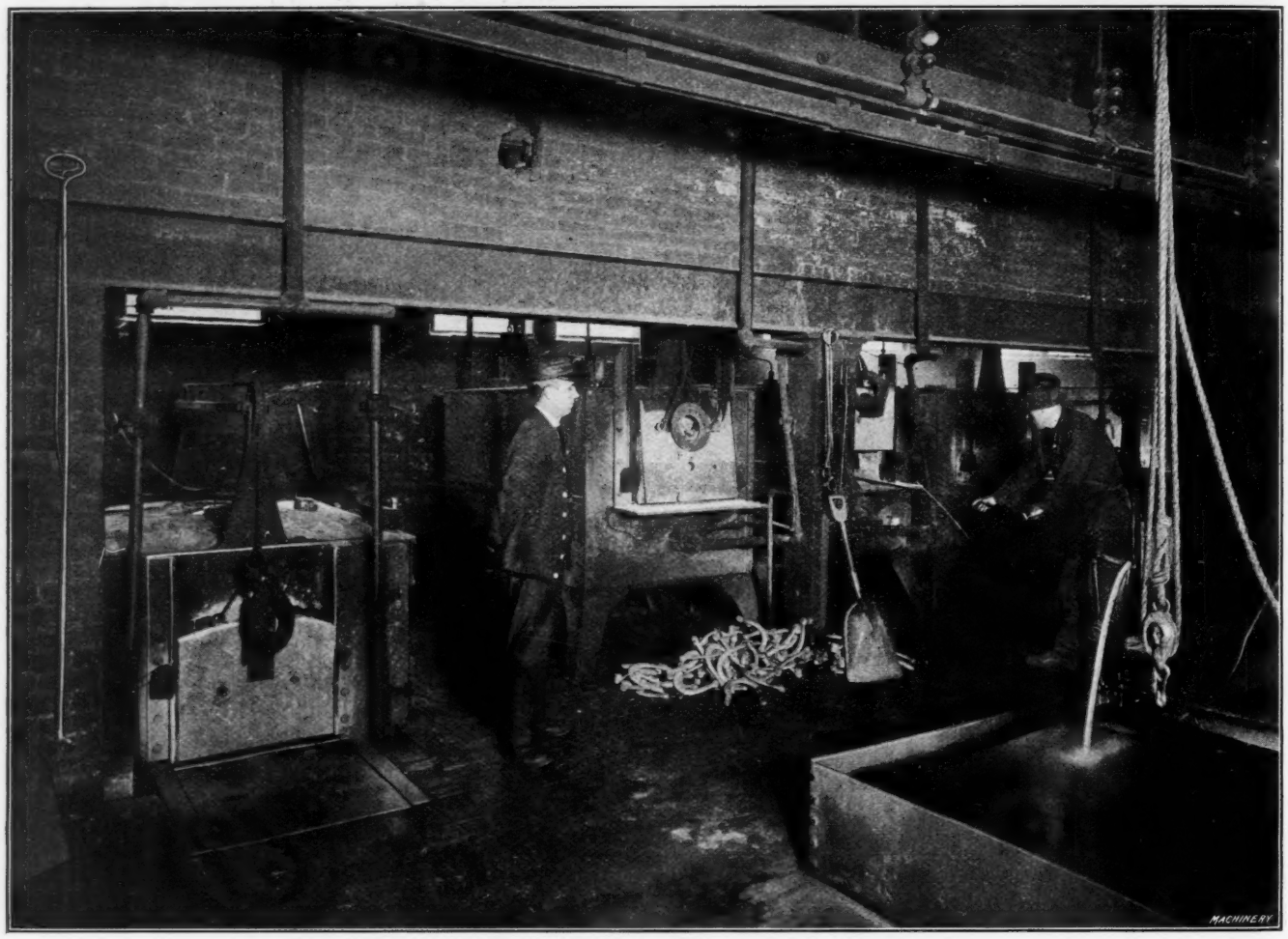


Fig. 5. Arrangement of Hardening Furnaces and Quenching Tanks

To be assured that the furnace temperatures are correct, a pyrometer system has been installed. Thermo-couples have been inserted in each furnace and the indicating meter is located in a separate room. Only one indicating meter is required to show the temperature in some twenty-four furnaces. One man has charge of this room and his only duty consists of operating the pyrometer to ascertain the temperature of each furnace at intervals of a few minutes, and to see that the furnaces are kept at the temperature desired. By means of electric lights, he gives the furnace operator a signal when the temperature of any furnace is too high or too low; and then he insists that the man at the furnace adjust the valves to bring it back to the correct temperature.

The signals consist of three incandescent lamps that are shown on a steel bar above the door of each furnace. The central light is clear glass, while the upper one is red and the lower blue. When the temperature of the furnace is correct the central light is the only one that shows. This is best illustrated in Figs. 2 and 3, where all the furnaces show the

can be made hard to resist frictional wear or any tendency to crush or deform, while the low carbon center, or core, will remain soft and ductile, and thus make it difficult to break the piece with any of the severe shocks or strains it receives when in use. This carbonizing is done after the piece has been machined to the proper size and shape. Grinding is the only kind of work that is practical after the steel has been carbonized.

In performing the carbonizing operation, the work is packed in iron pots and heated in furnaces in just the same manner as shown for the annealing operations. The material in which the work is packed differs, however, as it must be a carbonaceous instead of non-carbonizing material. Bone, charcoal, charred leather and numerous other materials have been used for this purpose, both alone and in various combinations. Figs. 1 and 3 illustrate the methods of packing the work. Fig. 1 shows the bank of furnaces used for carbonizing. The first of these is a Frankfort furnace, which was installed by the Strong, Carlisle & Hammond Co., while

the others were built by the Brown & Sharpe Mfg. Co. The special annealing furnaces built by the company for their own use are shown in Fig. 3.

In the lower left-hand corner of Fig. 3 will be seen part of a pot that has been sealed up ready to insert in the furnace with the two-wheeled truck that is being handled by the man at the left of the picture. Beside it are two pots that are only partly filled. These show the way the work is laid in the carbonizing material. Each steel piece is kept at least one inch away from all other pieces. Then the carbon can penetrate all parts of the outer surface when the pot and its contents are heated to a temperature that is high enough to make the steel so hot that it will absorb carbon.

The amount of carbon that is thus injected into the outer surfaces of the steel and the depth to which it penetrates are governed by the composition of the steel; the nature of the carbonizing material; the temperature of the furnace; the larger will be the amount of carbon that it will absorb in a given time; and the greater the depth to which it is possible to make the carbon penetrate. Owing to the grain of the steel becoming gradually coarsened by each degree that the temperature is raised above the transformation point, there is a limit to the heat that can be successfully used when carbonizing steels. When heated too far above the transformation point the grain begins to crystallize, and at still higher heats the crystals begin to separate from one another. When these small cracks appear between the crystals the usefulness of the metal has been destroyed and it can only be restored by remelting and rerolling or reforging. Before the crystals begin to separate, the original fineness of grain can be restored by allowing the steel to cool and afterward heating it to a little above the transformation point and then suddenly cooling it by quenching in oil or water. This is the hardening operation and if properly done it will

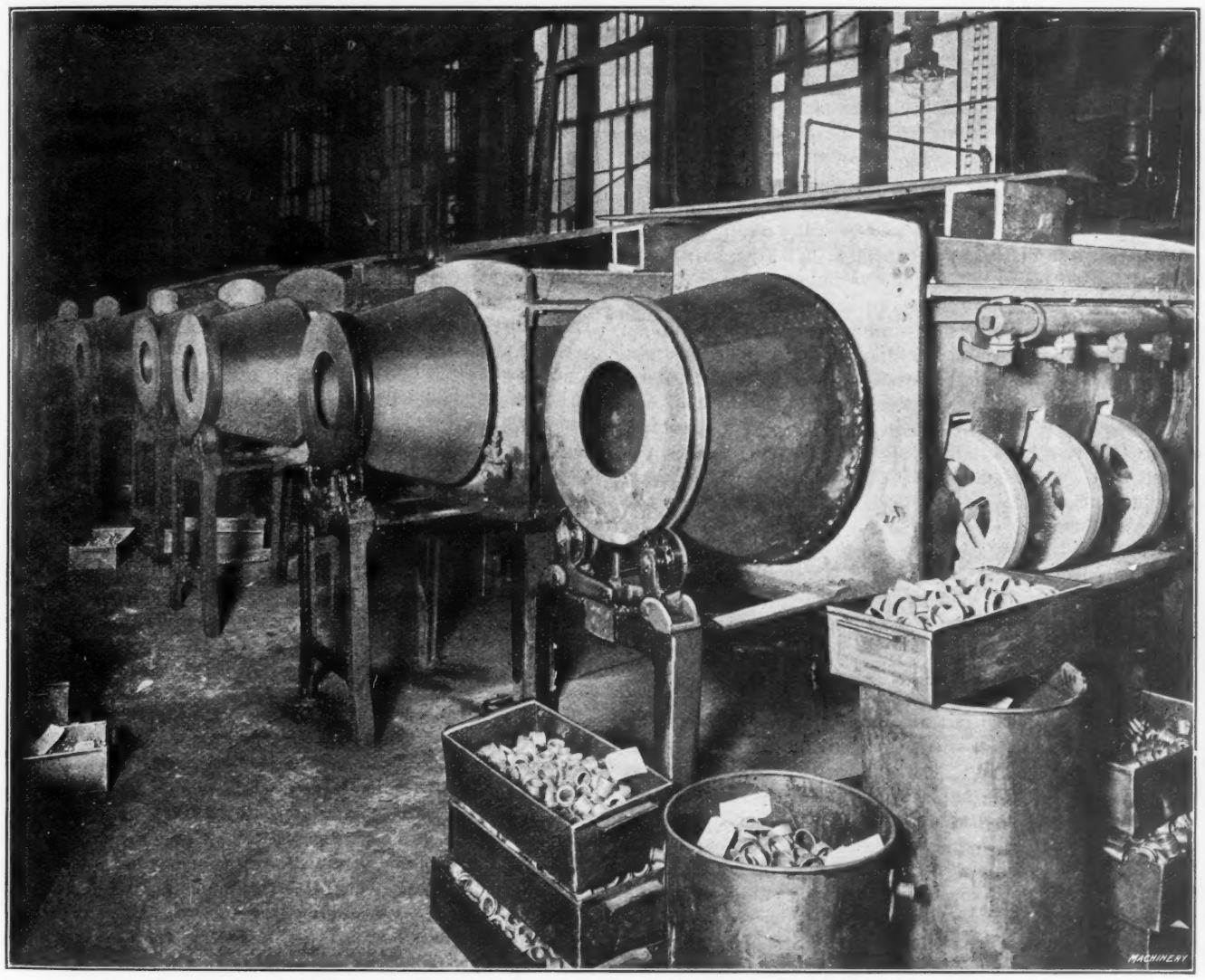


Fig. 6. Rotary Furnaces used for drawing the Temper of Roller Bearing Parts

and the time the work is held at this temperature. The outer shell of the steel piece is usually made to absorb enough to give it 1.00 per cent of carbon. This percentage of carbon gradually diminishes toward the center of the piece until the low carbon content of the original metal is reached. This will vary from 0.10 to 0.20 per cent of carbon, as it is such grades of steel that are used for parts that are to be carbonized. Many of the high-grade alloy steels, as well as the ordinary carbon steels, are carbonized to various depths and with various percentages of carbon. These alloys give much better results in bearings than any of the carbon steels, and are nearly always used for the parts of bearings that have to withstand great strains. They are more expensive, however, and hence some of the cheaper bearings are made from the carbon steels.

The higher the temperature to which the steel is raised, the more quickly will it absorb carbon to a given depth; put the steel in as good a condition as though the grain had not been coarsened by overheating.

Therefore, carbon steels with a transformation point of 1500 degrees F. or below can be held at a temperature of 1650 degrees for several hours, when carbonizing them, and the coarsened grain can then be brought back to its greatest degree of fineness by the subsequent hardening operation. Some of the alloy steels with a transformation point of 1650 degrees F. can be heated to 1750 degrees for the carbonizing operation. These temperatures will give a rapid penetration of carbon; they also give as high a percentage in the outer shell as is required for practical work and to the necessary depth. Under ordinary conditions, a temperature of 1650 degrees F. maintained for one hour will cause the carbon to penetrate to a depth of 1/64 inch; three hours will give a depth of case of 1/32 inch; nine hours a depth of 1/16 inch; and twenty-four hours will give a depth of 1/8

inch. It is very seldom that the high carbon content is required for a depth of more than 1/16 inch and thus each lot of steel parts can usually be carbonized in a day's run.

After deciding what is the best temperature for the carbonizing heat, the best results can only be obtained by keeping the furnace uniformly at that temperature during all the time the work is in the furnace. Hence the same pyrometer is installed on these furnaces that is used on the annealing furnaces and on all other furnaces used in the heat-treating department. Then the time will decide the depth of penetration, and when the desired depth has been obtained the pot should be taken out of the furnace and allowed to cool slowly to below 600 degrees F. After that, the work can be taken out of the pot and allowed to cool quickly. Then it is ready for any hardening and tempering that is required. In Fig. 4 is shown the way the work is removed from the pot and sorted. The square pots are used for carbonizing work and the round ones for annealing. Thus there is no excuse for getting the work mixed in these two operations. Some take the pot out of the furnace and dump the work directly into the quenching bath for the hardening operation. The carbonizing temperature is usually too far above the transformation point, however, to give the steel the finest grain that it is capable of assuming. Thus it is far better to allow the work to cool down from the carbonizing temperature and then re-heat it for the hardening operation.

In hardening carbonized bearing parts, the best results are obtained by giving them a double heating and quenching to get the proper degree of hardness in both the hard outer shell and the soft core. This is due to the fact that the transformation points of high and low carbon steels occur at different temperatures, which are often 200 degrees apart. The steel should first be quenched from the high transformation point of the low carbon steel in the core and then reheated to the lower transformation point of the high carbon steel of the outer shell and again quenched. This produces bearings that it is almost impossible to break or crush under the load that they are designed to carry. It also gives them a wearing surface that will last a long time, as its grain is very fine and dense.

Some parts of the bearings are made from steel that contains the desired amount of carbon. These parts are hardened and tempered without being subjected to the carbonizing process. Such work is inserted in furnaces and heated to the hardening temperature without being packed in iron pots. When it has reached the correct heat for hardening, it is quenched in tanks of oil or water. If the hardening temperature has been just right, *i. e.*, just above the transformation point, the steel will then be in the hardest state to which it can be brought. It will be what is termed "glass hard," and hence brittle, and must be heated again to a high enough temperature to draw out enough hardness to obtain the desired degree of toughness.

The hardening temperature is the most important one and will not allow of as much variation as the annealing and carbonizing temperatures, if the best results are to be secured. If the steel is not heated up to the transformation point before it is quenched, the change in grain structure will not take place and the steel will be no harder than when it leaves the rolling or forging operations. If heated above the transformation point the grain coarsens in proportion to the number of degrees of temperature above this point. As it coarsens, the physical properties of the steel deteriorate. Each rise of 50 degrees F. above the transformation point will lower the elastic limit of carbon steels something like 5000 pounds per square inch, and other physical properties in like proportion. Thus the greatest strength that can be given the steel can only be obtained at a certain temperature. Any variation from this means weaker metal. Its capacity to resist fatigue also loses somewhat over 15 per cent with each 50 degrees rise above the transformation point.

In hardening the various parts of Timken roller bearings, furnaces similar to those shown in Fig. 5 are used. These are the Strong, Carlisle & Hammond Co.'s furnaces. When the correct temperature has been obtained, the work is thrown into one of the tanks shown at the right, so it will suddenly cool. The hot steel would naturally raise the temperature of this bath, and when raised too high the steel would not be cooled quickly enough to produce the greatest degree of hardness. To overcome this difficulty, the liquid is kept constantly in circulation by allowing the hot fluid to overflow at the top of the tank and run into a larger tank which is located below the level of the floor at a considerable distance away. This allows the liquid to cool by radiation, and it is then pumped back into the tank. The stream that can be seen steadily flowing into the tank is the cool liquid coming from this pump. A wire basket lies in the bottom of the tank and covers nearly the entire bottom. When the hot steel is thrown in the bath it is caught in this basket. The block and tackle shown is used to raise the basket out of the tank when it becomes filled with work which has had time to cool. The basket is merely raised above the level of the tank and the work dumped into cars or trucks that convey it to the other parts of the shop where it is to be used. Thus large quantities of work can be handled during a regular work day at a very small cost.

The accuracy of the drawing temperatures is also very important. When too much of the hardness is drawn out, the bearing parts will be too soft and will compress when under load. When too little of the hardness is drawn out, they will be too hard and brittle and thus likely to crush or break. To get the greatest accuracy in the drawing temperatures, the furnaces shown in Fig. 6 are used. The heating chambers of these furnaces are revolving retorts through which the work slowly travels until it has absorbed the highest temperature of the furnace. It then drops out at the far end into receptacles which are removed when they are full. The retort has a spiral web on the inside and this, in connection with the speed at which the retort is revolving, controls the time that is consumed for the work to travel through. The work is dumped into the round hole shown at the near end of the furnace. Thus the tempering is done automatically and the furnace operator can devote most of his time to adjusting the burners, so the furnace will be maintained at the correct drawing temperature. These furnaces can also be used for automatically heating bearing parts to the hardening temperature and then dropping them into a quenching bath at the far end of the furnaces. The retort would then have to travel slower to allow the work more time in which to reach this higher temperature.

* * *

THE FIRST STEAM ENGINES

The first steam engines are said to have been built for use in pumping water out of mines. They were connected to vertical reciprocating pumps and were built with vertical cylinders. As it was not considered practical to place the engine directly over the mine-shaft, the heavy parts were placed at one side and a beam was used to reach over the shaft and make connection with the pump rod. At a later date the same style of engine was applied to drive mill machinery, the pump rod being connected with the crank which drove the shafting. This type of engine was used for several generations before a man came along who saw that the beam was unnecessary where there was no pit's edge to reach over. This is but an indication of the value of experience in power transmission and other engineering problems, and it is the accumulation of knowledge in this way that enables present-day designers to work out a transmission system to meet existing conditions. Various types of transmissions are used to meet the complex requirements of modern manufacturing plants. The development of these drives is the result of experience, and in order to get the most satisfactory results from a given installation it must be of the type best suited for the work; the equipment must also be correctly installed and properly cared for after installation in order to obtain the maximum efficiency.

* * *

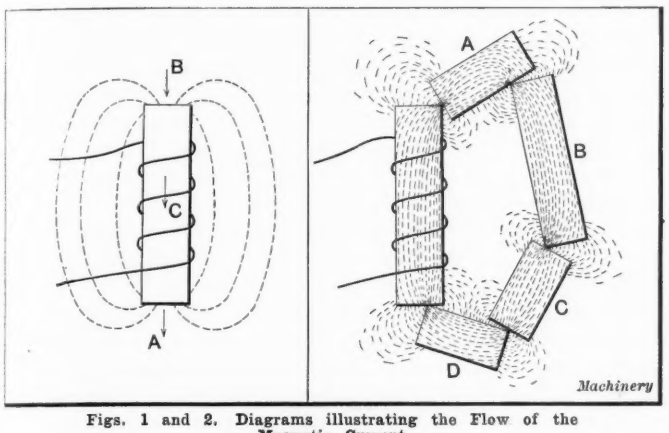
If iron is present in sufficient amount in brass castings, they will be hard and difficult to machine. The iron content should not exceed 0.5 per cent, in order to make good yellow brass castings that can be easily turned.

THE INSIDE OF THE MAGNETIC CHUCK—1

CHUCKS FOR VARIOUS PURPOSES AND PRINCIPLES OF DESIGN

BY HERBERT L. THOMPSON*

From the average mechanic who is not familiar with their various uses, magnetic and electrical appliances for shop use still receive a certain amount of distrustful indifference. This is undoubtedly the reason why they are not in more general use, and it is reasonable to believe that a better knowledge of the simplicity of their construction and operation would greatly add to their prevalence in all modern shops, both for tool work and manufacturing. Prejudice is often responsible for discrimination against magnetic chucks,



Figs. 1 and 2. Diagrams illustrating the Flow of the Magnetic Current

but if the tool designer would only realize how extremely simple they are, and how efficient for certain classes of work, we would see a great many more of them in use.

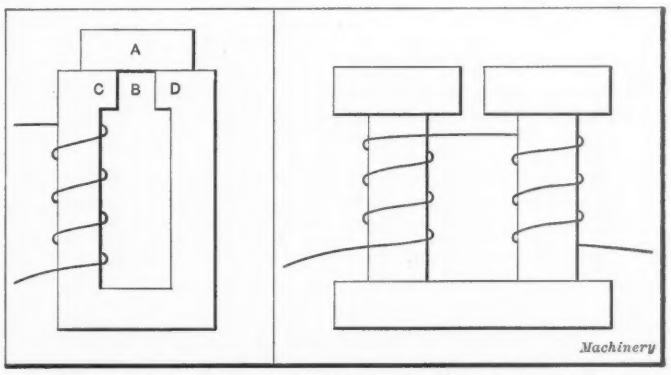
It is not difficult for anyone with an elementary knowledge of the principles involved to make good serviceable magnetic chucks; chucks that will hold any kind of iron or steel work and will operate on any direct-current lighting circuit of the voltage for which the coils are wound. The amount of machine work required in making them is generally slight and of the simplest kind, and when the low cost of the material and the operating current is considered, it is positively an expense to be without them, if any quantity of surface grinding, planing or milling is being done.

Every tool designer and tool-room foreman should be able to produce magnetic chucks for any work to which they are adapted. It is not a problem to which only an electrical engineer can aspire; on the contrary, the ordinary possessor of common sense and a little ingenuity can originate chucks of suitable sizes and shapes for a great variety of purposes, if he but knows approximately how to provide a proper magnetic circuit, energizing coils of proportionate size, and can use Ohm's law to determine the size of wire to employ in the coils to accommodate the voltage upon which the chuck is to be used. By computing the absolute resistance of the magnetic circuit and using a technically correct coil, a chuck could be made that might operate on a few cents worth less of current per week than one designed by the layman, but it is extremely doubtful if the possible economy would repay one for the extra effort. At any rate electrical formulas of this kind are very unsatisfactory, owing chiefly to the fact that the magnetic resistance of iron varies greatly, even in different parts of the same piece.

Comparatively few magnetic fixtures are employed for other than plain flat work on the surface grinder, the many obvious advantages obtained by the use of even an indifferent chuck in this connection having won them a place of some prominence. For milling, planing or turning, however, they have never been taken as seriously, and the reason is simply a deplorable lack of confidence in the holding power of a magnet for work of this character. While it is true that the ordinary surface grinder chuck is not intense enough to hold some of the heavier work, it is a simple matter to design chucks of enormous holding power for almost any shape of work. Of course, it is necessary to provide stops to take up the tool thrust on most heavy work, but as this in no way detracts from the value of the chucks as operation savers, it cannot be urged as an argument against them. Even non-magnetic metals such as brass or aluminum can be held on specially designed magnetic fixtures. To be sure, they cannot be held directly by the magnetism, as iron or steel could, but iron or steel clamping levers can be provided which are so disposed that the magnetic force will draw them against the work to be held. Perhaps this would not constitute a magnetic chuck, strictly speaking; but it is one of the variations that can be resorted to, and it will give instantaneous clamping and unclamping of the work which is the main consideration. Sometimes it is necessary to hold even iron or steel pieces in this way if they are very small or thin, as it is unhappily a fact that a piece of work must have a certain amount of cross-sectional area in order to be strongly held by any magnet.

Elementary Principles of Magnetic Chuck Design

The range of work that can be done with magnetic chucks is so enormous and of such diversified character that a description of a few of the different forms would avail little toward imparting useful knowledge to one who wishes to design them for special work, unless some attention was given to the elementary principles governing the production of an efficient electro-magnet. In other words, while the common type of chuck for flat work is very useful in the tool-room and at times in the manufacturing departments, it is the ability to adapt the magnetic circuit to any special work of varied shapes and sizes that is particularly valuable, for often work is held in a clamping fixture which consumes from 20 to 80 per cent of the operation cost in the clamping and unclamping, though it could be held with a magnet and gripped or released by simply throwing a switch. While it is not necessary to have more than a rudimentary knowledge of electricity in general to construct a good serviceable magnetic chuck, there are a few simple facts that must be borne in mind if the greatest success is to be obtained. The formulas given in the textbooks are suitable for dynamo design, in which a fraction of one per cent in efficiency is important; they are quite intricate, and as such accuracy is



Figs. 3 and 4. Diagrams showing the Function of the Air Gap and the Method of winding the Coils

unnecessary for magnetic chuck purposes, it would be a waste of time to master them. In fact, it is possible to explain all that is necessary by the use of a few simple diagrams.

A bar of iron upon which a coil of insulated wire is wound in one direction becomes a magnet when a direct current of electricity is passed through the coil. The greater the amperage (quantity) of the current, the stronger the magnet will be, up to a maximum point, which is called the "point of saturation." If the number of turns of wire about the bar is increased, the magnetism will increase in direct proportion, provided the amperage of the electric current is maintained and the magnetism does not approach too closely to the point of saturation.

The magnetic force caused by the passage of the electric

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current around the bar exists in the form of a magnetic current which enters one end and leaves at the other, as shown by the dotted lines in Fig. 1. It is apparent that the current that leaves at *A* is the same as that entering at *B*, and that there is a circuit up through the iron bar and back to the starting point through the surrounding air outside of the coil. Iron is an excellent conductor of magnetism, and for that reason the current travels easily through the bar; but in its effort to return outside of the coil it is greatly spread out, because it requires as much more air for its path as air is a poorer conductor than iron. To be more explicit, a conductor for either a magnetic or electric current must present a path of a cross-section increasing directly as the resistance of the material used. This is of paramount importance, as any increase in resistance results in a corresponding decrease of current, and if the material composing the circuit is of poor conducting quality, there must be enough of it to carry the current, as the resistance of any conductor varies directly as its cross-sectional area.

A bar magnet such as shown in Fig. 1 is not fit for any but explanatory purposes, as it really constitutes only a part of a magnet. That is to say, a complete magnet would be one in which the whole magnetic circuit was provided with a path of good conducting material, both inside and outside of the coil, so that there would be no loss through the resistance of an air gap. An approximation of this condition can be seen in Fig. 2, in which the poles of a bar magnet like Fig. 1 are roughly connected by the pieces of iron *A*, *B*, *C*

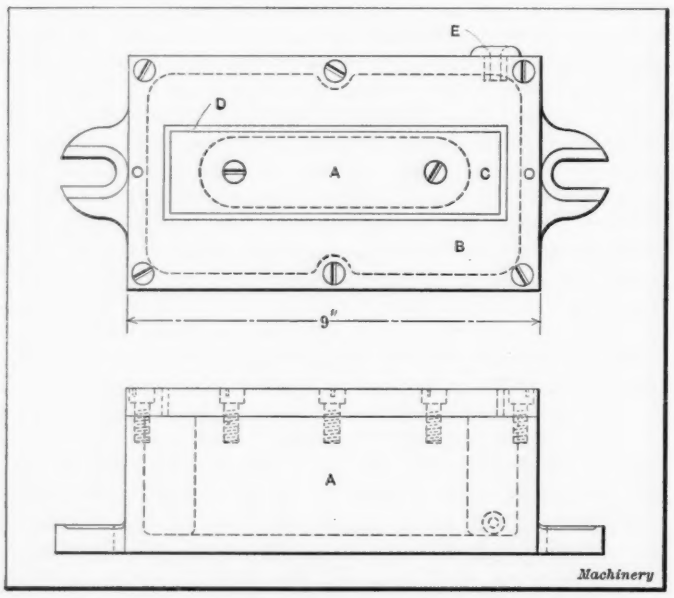

Fig. 5. Three-piece Gray Iron Chuck for grinding, planing or milling Work

and *D*. The dotted lines show how the magnetic current flows through them, and how it is no longer necessary for it to use the air except at the joints between the pieces, which offer too small a cross-section of iron for the conduction of all of the current without some help from the surrounding air.

A magnet will attract outside iron or steel only when the piece attracted constitutes a part of the path of the magnetic current, and the more its presence lowers the resistance of the circuit, the more forcibly it is attracted. Thus, at *C*, the magnet shown in Fig. 1 is not attractive, because a good conducting path is here already established, but at the poles *A* and *B* a strong attraction is felt, which is greatly increased by helping the outside part of the circuit with the pieces *A*, *B*, *C*, and *D*, Fig. 2. The magnet shown in Fig. 2 is feebly attractive only at the junction of the various pieces, as these are the only places where an improvement could be made in the conducting path; but any one of the pieces would resist being separated from its neighbors, and if, for instance, the piece *B* was removed, pieces *A* and *C* would become poles with the entire magnetic current spreading through the air between. They would strongly attract each other or any piece of iron brought within range of the greatly widened current between them. In fact, the entire energy of the magnet would be concentrated toward closing the gap between the pieces *A* and *C*.

The Function of the Air Gap

If the various pieces composing the system shown in Fig. 2 were welded into one continuous link, it would become a perfectly closed magnetic circuit, as there would be no gap for the current to cross through the air. If this was the case, however, the link would be useless as a magnet, as the whole of it would be as inactive as the magnet shown in Fig. 1 is at *C*, and for the same reason. As this is the case, it is highly essential in order to obtain the best results that a magnet should have a continuous conducting path of ample cross-section, except for one gap across which the work is to be held. Fig. 3 shows an example of a magnet of this kind and *A* represents the work in place across the gap *B* from pole *C* to pole *D*. It should be noted that the work *A* has sufficient area of contact with both the poles *C* and *D* to carry all of the magnetism, and that as the work *A* has approximately the same cross-section as either side of the link, it will form a path for the current without appreciably increasing the resistance of the whole circuit; therefore, the entire energy of the magnet will be expended upon holding the work *A* in place.

It is not strictly true that the iron path of any magnetic circuit will carry all of the current. It is necessary for all of the current to pass through the coil, but as the resistance of the iron is increased as the amount of current it carries increases, it is a fact that there will always be some small part of the current that will follow back through the air; for while air is greatly less conductive than iron per unit of cross-section, still there is always so much more air than iron available that it offers some inducement to the current. To receive the greatest possible efficiency from any magnet, it is necessary to have the polar gap adjacent to the coil, so that the piece to be held will bridge the most intense part of the circuit. With this object in view, it is desirable at times to use magnets of the form shown in Fig. 4, in which there are two coils with each pole piece as close as possible to the place where all of the magnetic current concentrates to enter or leave the coils. It is necessary to wind the coils of the magnet illustrated in Fig. 4 in directions as shown, as the direction in which the magnetic current travels is dependent upon the direction in which the energizing electric current flows; and if both magnetic currents moved in the same direction in each core (conductor inside of coil) they would oppose each other and result in no magnetism if they were of equal strength.

It is always desirable to have any magnet as nearly integral as possible, as a joint between two pieces of iron composing a magnet will always impose some resistance upon the current, however well they may fit. At least three pieces, however, are necessary to compose most magnets, as it would be very difficult if not impossible to apply the coils to the cores if the enlarged pole pieces were not removable. The objection to these joints is overcome by giving them as much area as possible and making them very smooth and close fitting. Careful workmanship at these points will make it possible to use more than three pieces in one circuit, when necessary, without unduly impairing the pulling power of the magnet.

Materials for Electro-magnets

Strictly speaking, iron is the only material that will make a satisfactory electro-magnet, but certain kinds of iron give better results than others, owing to their lower magnetic resistance. From the standpoint of efficiency, well annealed Swedish iron is not surpassed for magnetic chuck work, but as it is necessary to forge it into shape and do a great amount of machine work on it afterward, gray iron generally proves to be more practical, especially for chucks of the larger sizes. A magnet composed of soft Swedish iron would possibly hold with as much as 30 per cent more than one of similar design made of gray iron; but it would cost so much more than the cast-iron chuck that, except in case extremely small work was to be held, it would prove an unnecessarily expensive refinement. However, small rotary chucks are often advantageously made of Swedish iron forgings, as it is necessary to

machine them all over to insure good running poise. Whatever iron is used, it must be soft. Forgings should be well annealed after hammering, and if the gray iron castings should be somewhat chilled on the corners, it would pay to discard them and get new ones.

Forms of Magnetic Chucks

The simplest form of magnetic chuck is one having but two poles. There may be any number of coils, but if there is only one gap in the magnetic circuit it constitutes a "bipolar" chuck, and where the work to be done will permit its use, this form of chuck is the simplest and by far the cheapest one to make. Figs. 5, 6 and 7 are examples of bipolar chucks for various purposes. Fig. 5 is a three piece gray iron chuck having only one coil. It will hold any kind of flat work very nicely for surface grinding, and will also

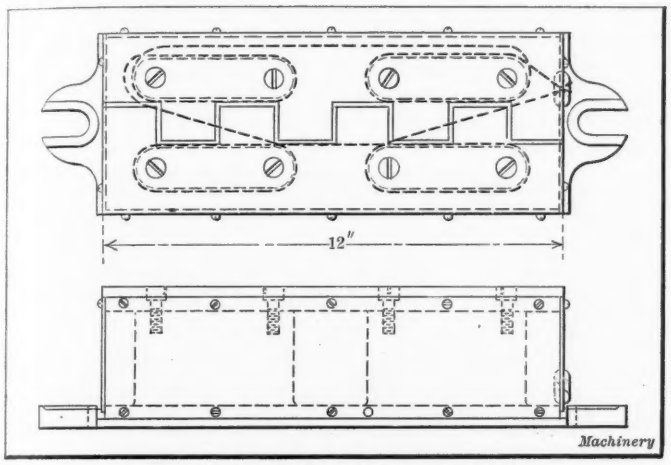

Fig. 6. A Four-coil Electro-magnetic Chuck

hold pieces that are of fair size and have a good contact surface for milling or planing, if suitable stops are provided so that the cutter thrust cannot slide the work off the chuck surface. This is probably the simplest kind of a chuck and is a very good one for the milder kinds of work. The coil is entirely enclosed with the iron frame, making it dirt and moisture proof. It is almost as easily made as an iron box, and while the drawing shows only a gap of plain rectangular outline, it could be made very intricate, if the nature of the work to be done required it.

The core *A* of this chuck is cast integral with the base and sides. The top is composed of two separate pieces *B* and *C*, and a filler *D* which prevents magnetic contact between the pieces *B* and *C*. The form wound coil is dropped over the core *A*, and the supply wires enter and leave through the fiber bushing *E* in the side of the chuck. When an electric current flows in the wire composing the coil, a magnetic current is generated in the core *A* which circulates from end to end of the core *A* through the base, sides and top of the chuck, jumping the gap through the filler *D* and the air above and below the top plate. The filler *D* is an alloy composed of nine parts lead, two parts antimony and one part bismuth. It has the peculiar property of expanding upon cooling from the molten state. This greatly simplifies the making of the top of this chuck, which is accomplished in the following manner: The parts *B* and *C* are separate rough castings, each having been snagged fairly smooth on one side. They are laid with this smooth side down upon a flat surface, with the piece *C* carefully centered in the hole in the piece *B*. The molten filler alloy is poured between them until it overflows on the top, and when it cools its expansion holds the pieces *B* and *C* in position with absolute rigidity, though they are magnetically separated. The entire rough top plate can now be planed on both sides and the edges, exactly as if it was one piece, it being only necessary while planing the edges to maintain the position of the piece *C* so that when screwed to the base of the chuck it will center fairly well upon the core *A*, as of course, *C* acts as the pole piece of core *A*, while the piece *B* conducts the magnetic current from the sides and becomes the other pole when close to the gap. The piece *C* could be made almost any shape that would facilitate holding the work, but should be made as short in outline as possible, as the magnetic leak through the filler and air across the gap will depend upon the amount of pole area and the distance across the gap, which should never be less than ⅛ inch.

After the top plate is planed, drilled and counterbored for the screws and dowels, it only remains to plane the bottom and top of the base, and drill and tap the holes for the screws, dowels and the fiber bushing *E*, which completes the machine work on this chuck. If the work to be done warrants it, more than one top plate could be made for the base, each having a form of gap to accommodate a certain piece of work; it is such a simple matter to change them that it would probably prove an economy. Stop-pin holes can be drilled into any of the top plates to completely outline the work, if necessary, so that work requiring close location can be handled rapidly. Compared to any form of clamping jig, this little chuck should make an excellent showing both as regards adaptability and cost for any work within its scope.

Perhaps the chief objection to this form of chuck is the fact that one of the poles is too far from the coil, resulting in some loss of holding power; but for light work the simplicity and general compactness make it ideal. Such a chuck should not be made much larger than the dimensions on the illustration; in fact, no single coil chuck should be made much larger unless for holding single very large pieces; and even then a number of small coils would concentrate the force more and make a much more satisfactory chuck.

A Four-coil Magnetic Chuck

For holding work for severe planing and milling operations a chuck like the one shown in Fig. 6 is to be recommended. It will hold considerably more than the design illustrated in Fig. 5, because it has four coils and each pole is adjacent to the coils for its whole length. It is almost as simple as the chuck shown in Fig. 5, as it comprises only three iron parts. However, as it cannot be enclosed by integral iron sides without short-circuiting the polar gap, it is necessary to enclose the sides and ends with some non-magnetic material, so sheet brass is used. Of course, this does not make it water-tight, but as magnetic fixtures are seldom used with water or oil this does not detract much from the value of this shape. The

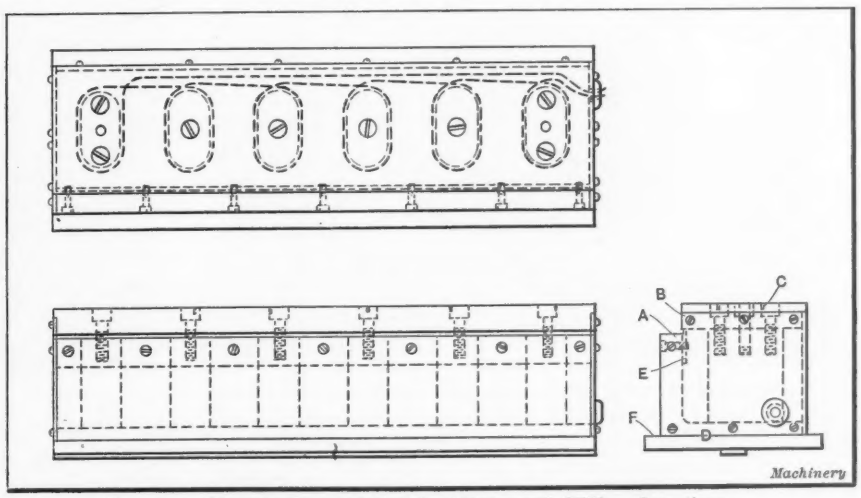

Fig. 7. A Magnetic Chuck adapted for Planing and Milling Operations

top plate for this chuck is made in the same manner as the one in Fig. 5, but as neither pole piece in this instance embraces the other to any extent, it is doubtful if the expansion of the filler alloy would bind the two halves together firmly enough unless anchor holes were drilled or milled in the pole surfaces to insure a good grip. This can be done very easily though, by drilling quarter-inch holes at varying angles along the edge of the rough plate. The shape of the gap line can differ from the one shown, but it must not approach too

close to the junction of the cores with the top plate, as this would result in a partial short-circuit that would ruin the holding power of the chuck.

Very long pieces of work can be held with a chuck of this kind, as there is no limit to the length of gap line that can be made active if enough coils are used. The dimensions on the illustration show good proportions, and approximately the same number of coils should be used per unit of length, on any longer chuck. That is, if a chuck were to be made one-half again as long as the one shown, it should have six coils instead of four. In placing the coils on this chuck, great care should be used to see that they are connected as the drawing shows. Both coils on one side have the same polarity, and in order to accomplish this the electric current must pass around them in the same direction. The coils on the other side must both have opposite polarity to those on the first side, and any deviation from this order will result in partly or wholly neutralizing the chuck.

A Useful Chuck for the Planer or Milling Machine

When work is to be planed or milled parallel and at some definite angle with sides already established, a chuck of the form shown in Fig. 7 is certainly the most inexpensive and accurate fixture imaginable. The work is held by the poles *A* and *B*, and as the force is applied in both the vertical and horizontal planes, perfect location upon the chuck is the result. There are only two pieces of iron used in this chuck, the top plate *C*, the edge of which serves as pole *B*; and the base *D* which is integral with the six cores and the pole piece *A*. The filler in this case is a piece of one-eighth inch brass plate screwed to the pole *A*. It is shown on the drawing at *E*. One side and both ends of this chuck are enclosed by sheet brass, but the front is covered by the pole piece *A* and the filler *E*. No coils are supplied for the pole *A*, but their absence is compensated for by the shape and position of the poles, which present only their corners for magnetic leakage across the gap. As this chuck will often be made in very long lengths, the ledges *F* are provided for clamping it to the platen of the machine on which it is to be used. When in use, the current always warms the chuck to some extent, and if a long chuck were simply clamped at both ends to a cold platen, it would tend to bow up in the center to relieve the strain due to its linear expansion. For this reason it is preferable to place most of the clamping straps near the center of its length, and it is poor practice to draw them up very tight.

The poles *A* and *B* on this chuck are shown as they would be made for holding rectangular or cylindrical work, but they can be made to fit any shape of stock that would be necessary. Among other rather difficult operations that can be accomplished to advantage by the use of this chuck is the cutting of a perfectly accurate spline, or a flat side on a long piece of small round rod, the milling of absolutely parallel dovetail slides, or a number of parallel shoulders or slots in any long pliable work. This kind of work can even be done with the greatest accuracy when one or more rechuckings are necessary, as, for instance, in reversing to cut opposite sides of a dovetail slide or the vees of a straight ball race. Long work of this kind is seldom straight, owing to slightly unequal strains throughout the material; and this adds to the difficulty of holding it in any kind of a clamping fixture, as it will almost invariably bow up between the clamps. For this reason, a magnet is the only logical method of chucking, and it is also by far the most economical. The perfectly uniform attraction draws the kinky rod down to intimate contact with the chuck poles, and even though it is necessary to rechuck several times and the work springs a different amount after every cut is made, still each cut is parallel with its neighbor, regardless of how badly the whole piece may be bent. Of course, if the long pieces to be milled are castings, it will be necessary to give the first locating sides a fair average surface by hand or with the disk grinder, to prevent straining the crooked work straight for the first cut.

Light milling operations can be performed on this chuck without the use of stops of any kind, and if a stop is provided, the heaviest kind of back-gear milling cuts can be taken without fear of lifting or slipping the work. When a large number of duplicate parts of certain shapes require hand filing operations, no better bench vise could be wished; no manipulation is needed, and the pieces locate themselves if simply dropped near the poles. A magnet of this shape is also useful for locating work within its scope for jig-drilling; it is absolutely accurate, can be operated with one hand and in less time than any clamp. This is indeed a very useful form of chuck.

* * *

LIFE OF ELECTRIC POWER PLANTS

In a paper presented by C. M. Ripley before the annual meeting of the American Society of Heating and Ventilating Engineers, some statements were made regarding the long life of private electric power plants. It is an interesting fact that the oldest plant for generating electricity in a building in New York City was installed and put into operation less than four years after Thomas A. Edison announced the discovery of the incandescent electric light in October, 1879. George B. Post let the contract for a private electric plant in the Mills Bldg., opposite the Stock Exchange on Broad St., New York City, in 1883. This plant is still in daily operation. The fifteenth and nineteenth dynamos made by Edison have run every day for over thirty-one years and are still in perfect condition. Not only are the same dynamos in operation, but the original steam engines installed at the time by the New York Safety Steam Engine Co., now long out of business, are the sole means of driving the dynamos. H. J. Hardenbergh installed a private electric plant in the Dakota Apartments, New York City, in 1885 and some of the same apparatus is still in operation every day. The Evelyn apartment house has a twenty-five year old plant, consisting of one engine and dynamo, which is running every day. The Bank of New York has an outfit twenty-five years old which is held as a reserve but is run once a week to keep it in good condition. The Union Trust Co. for twenty-five years has had its same engines and dynamos running and at the present time they operate from eight in the morning to ten in the evening. The Tower Bldg., the first of a modern skyscraper type recently razed, had a power plant twenty-four years old. Many more examples of plants a long time in operation are quoted by the author. It has been the custom of many engineers and architects to assume a five per cent depreciation as the proper annual charge off on such installations, but this evidently is too high. Taking into consideration private electric plants installed as early as 1900, the results of the investigation show that twenty-four plants show less than five per cent depreciation, twenty-nine plants show less than four and a half per cent depreciation, seventeen plants show less than four per cent, sixteen plants show less than three and a half per cent depreciation and four plants show less than three per cent depreciation.

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AN UNUSUAL MODEL SHOP

We usually think of a shop where miniature models of machinery are being made as occupying one or two rooms in an out-of-the-way corner, and employing but a few men. In view of this, it is interesting to note that the Peter Koch Model Works, at Koln-Nippes (near Cologne), Germany, devoted entirely to the making of models of machinery, steamships, etc., employ 200 men on this work. Models are made for experimental and demonstration purposes, engineering education and for exhibitions, museums, etc. As an example of what is accomplished in this line of work may be mentioned a model of a universal rolling mill for I-beams having a capacity for beams up to 40 inches high. This model was made on a scale of from 1 to 20, and when completed was about 8 feet long, 3 feet wide and 20 inches high. The model was so perfect that machine steel billets could be rolled in it into I-beams ¾ inch in height. Steamboat models with all the external fittings almost perfect are also made, as well as miniature models of bridges and other structures and buildings. One of the particular uses for miniature models is for expositions, as it is often impossible to exhibit large machinery, and further, the model permits a much better perspective view of the whole mechanical arrangement.

COMMERCIALIZING A PRODUCT BY THE USE OF PRESS-WORK

PRESS-WORKING METHODS IN THE ECONOMICAL MANUFACTURE OF A PATENTED AUTOMOBILE WINDOW REGULATOR

BY CHESTER L. LUCAS*

Many a creditable device falls flat commercially because it cannot be marketed at the price which the cost of production demands. In this article will be described an ingenious device for the operation of the windows of an enclosed motor car, and the methods by which the product was gotten out at a price which would permit of its being marketable, still maintaining the highest possible quality. Figs. 1 and 2 show both sides of this device which is called the "perfect window regulator." It was designed and the details of production were worked out by A. K. Ternstedt, general manager of the Perfect Window Regulator Co., New York City. Its purpose is to raise or lower the window of a motor car, leaving it locked in any desired position; a side movement is also given to the window to throw it into its final position at the upper end of its travel. The "Perfect" window regulator is produced by press-work. Over twenty punched pieces, not including the chain, are employed in making, and no other machining operations, with the exception of the turning of a ball groove and the drilling of two or three holes, are resorted to. The remarkable part of the manufacture of this device is that it is almost entirely a product of punch and drawing presses. The die work is so perfect that the pieces are assembled without any fitting whatever, and the final operation of the mechanism is better than it would be if the pieces were produced by the more expensive machining operations often used on other products. The only parts of the regulator which are not made by press-work are two studs, three springs and a few screws, in addition to the balls in the bearings.

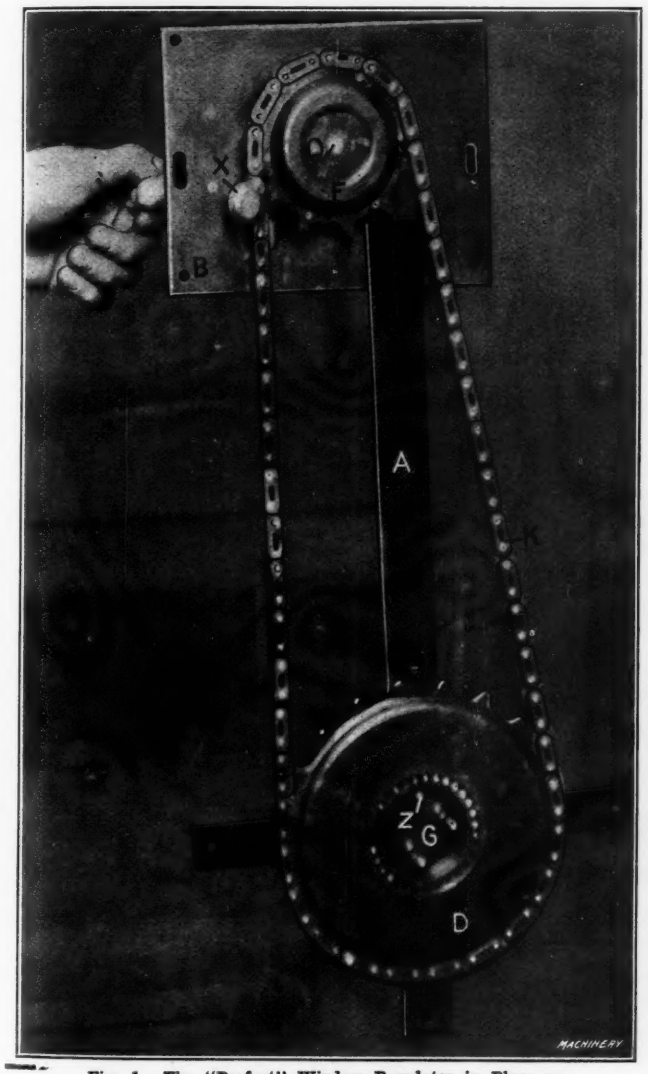

Fig. 1. The "Perfect" Window Regulator in Place on Rough Frame of an Automobile

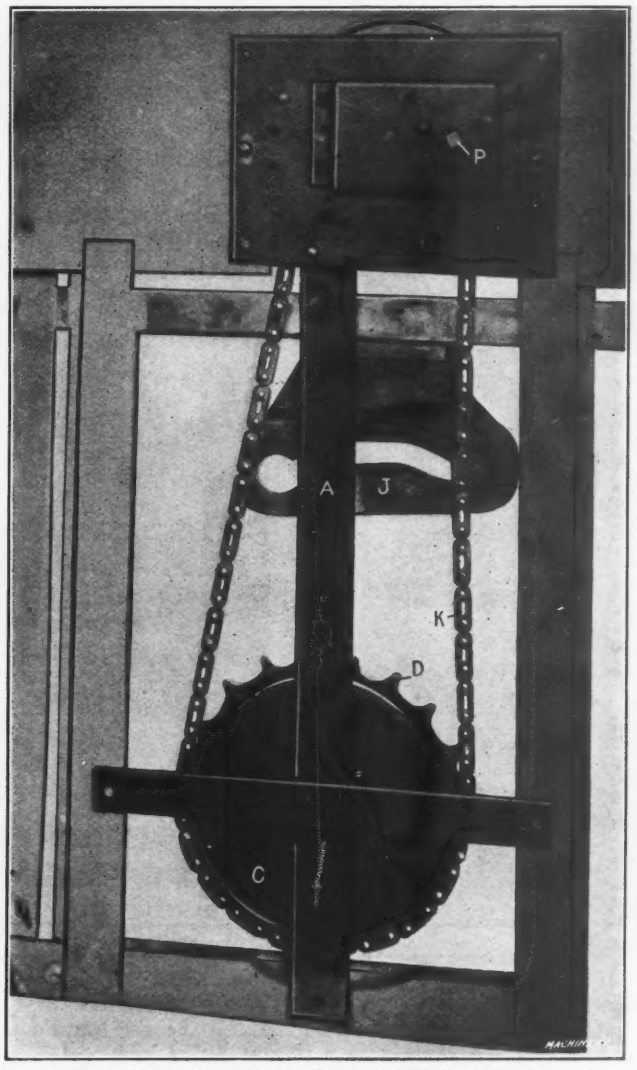

Fig. 2. Opposite Side of "Perfect" Window Regulator shown in Fig. 1

By referring to the various illustrations, some idea of the amount of press-work necessary may be obtained. Fig. 1 shows the assembled device from the rear; in Fig. 2 it is shown in place in the automobile before the inside finish has been applied to conceal it; in Fig. 3 are the various parts laid out for inspection, while Figs. 4 and 5 are sectional views through the sprocket mechanisms. The principal parts are the spacing bar *A;* the back-plate *B;* the cover *C* which fits over the lower sprocket; the lower sprocket *D;* the two halves *E* and *F* of the upper sprocket; the lower sprocket ball-race *G* and the upper sprocket ball-race *H*. The gear-box may be seen at *I*, the cam-plate at *J*, and the operating chain at *K*. These parts are the principal ones that are visible in the assembled device, but in the mechanism there are also smaller parts which can best be seen by referring to the sectional drawings, Figs. 4 and 5, showing the upper and lower sprockets, respectively. The mechanism in the upper sprocket is composed of the clutch shown at *L*, the clutch-cam *M* and the small torsion spring *N*. The pinion *O*, mounted on the stud *P*, is within the gear-box and meshes with a thirty-five-tooth gear on the spindle for the upper sprocket *Q*. The three parts which comprise the thirty-five-tooth gear are shown at *R*. A coil-spring *S* is used for compensating the weight of the window frame and glass. This spring works within the sprocket cover *C* and cover *D*, one end of the spring being looped around the lug that has been bent up out of the sprocket, and the other looped around the stud on the spacing bar that projects through a hole in the sprocket cover.

The chain is built up of punched links *U* and studs.

* Associate Editor of MACHINERY

Mounted on the chain are two hooks *V*, on which is supported a spiral spring *W* that takes up the slack of the chain. A roller stud fastener *X* is applied to the chain to support the stud and roller which operates in the cam-plate attached to the window sash. The spring *Y* that is mounted on the roller stud to prevent rattle at the cam-plate and the clip *Z* for closing the ball bearing filling slot in the lower sprocket, the miscellaneous screws and the steel balls complete the parts of the device. The thirty-five-tooth gear is composed of three punchings and the small pinion, while not made completely by press-work, has its teeth formed by a punch-press broaching operation, as will be explained later.

In order to understand the functions of the different parts, it will be best to first explain the operation. This can best be done by referring to Fig. 2, which shows the device installed in the framework of the limousine, for after it is in place the only visible part is a handle which fits upon the squared section *P* of the pinion shaft. This handle is not shown in the illustration. The window regulator is supported in the framework of the car by screws in the ends of the spacing-bar and cover plate. The glass window of the car is represented by *Z* in this illustration; the lower edge of the window, being mounted in a metal channel, forms the base that supports the cam-plate. Fig. 2 shows the window in its lower position; by turning pinion-shaft *P* with the handle which is provided the chain travels upward over the sprocket, carrying the stud that is mounted on the chain which, in turn, causes the cam-plate and window to be raised. As soon as the cam-plate, which fits around the stud, reaches the level of the upper sprocket's top edge, the stud slides along the slot in the cam-plate. The cam-plate is bent so that its surface lies in two different planes as is shown at *J*, Fig. 3. Therefore when the stud passes the bent section of the cam-plate, the cam-plate, and consequently the window, is thrown over sideways for the necessary distance to fit the window over the ledge which supports it when closed.

Taking up the parts of the device separately, the spacing-bar is made of two sections of strip stock which are sheared, the holes punched in the ends, offset and riveted at the center. In the back-plate, which is made of sheet steel 5/64 inch thick, there are twenty-nine punched holes. No drilling or counterboring is done on this plate. It comes from the punch press direct to the assembling bench. The lower sprocket cover *C* is a plain cutting and drawing operation, but the lower sprocket, itself, shown at *D*, is a more complicated piece of press-work. This is made from sheet steel 0.080 inch thick, and to leave it in its finished shape requires nine operations. These are as follows: rough-blanking and drawing, first redrawing, second redrawing, annealing, drawing edge down and setting up the center, swelling out for the ball-race, closing in the edge of the ball-race, trimming the piece and shearing in the spring lugs. A section of this sprocket appears in the line-drawing, Fig. 5, and the most unusual part of the work is the forming of the ball-race in the stock at the center, for it should be remembered that the ball-race is not finished by grinding or turning. When it leaves the dies it is done. The economy of producing this

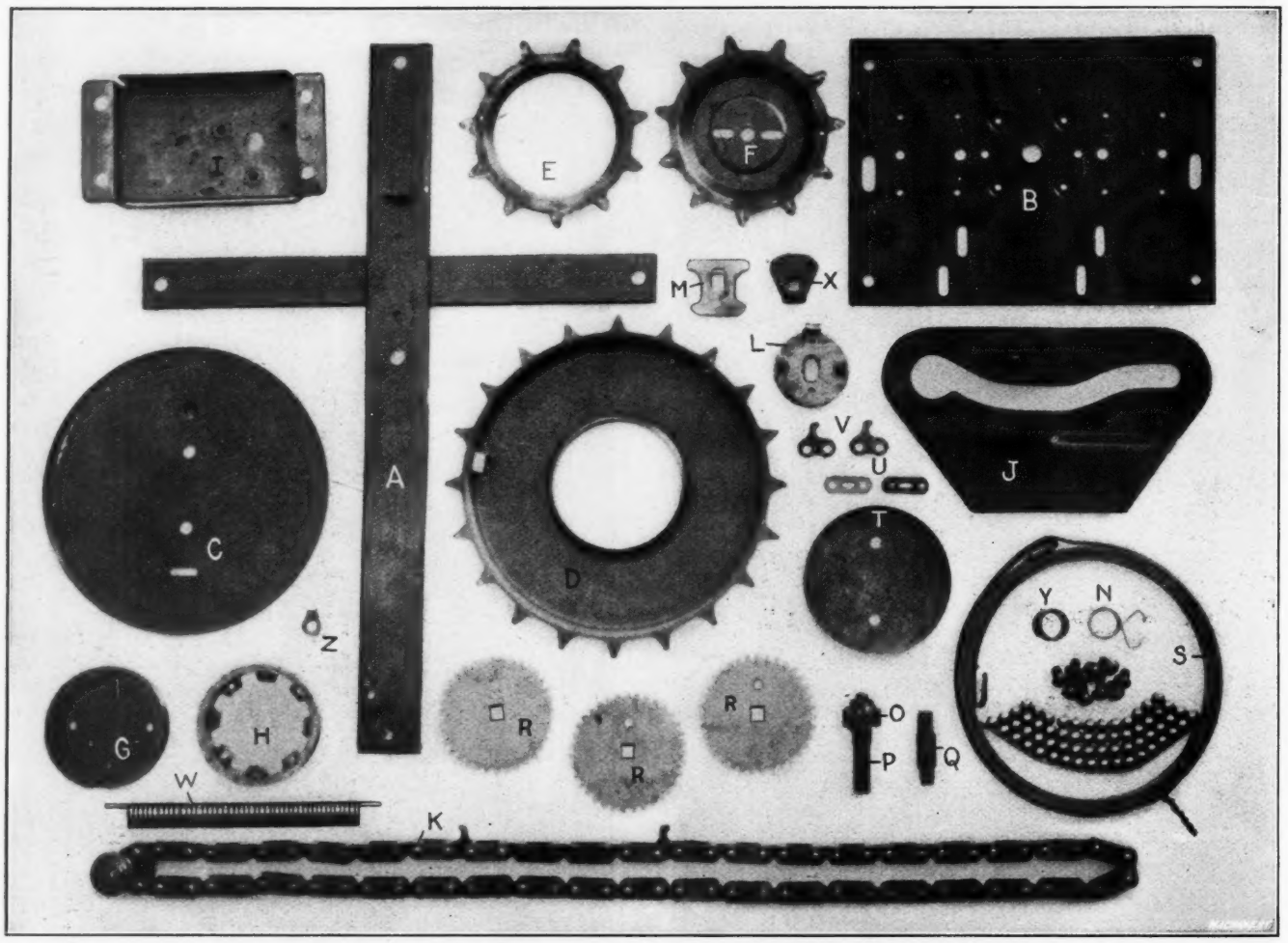

Fig. 3. The Various Parts of the Device—Nearly All Products of Press-work

part alone by press-work will be readily appreciated because the stock required and the machining operations that would be necessary to make the piece from solid stock or from a casting would be considerable in themselves.

The halves *E* and *F* of the upper sprocket are made in the same die. The first operations are comparatively simple, comprising the blanking and drawing of the piece, the trimming of the piece and the piercing of the hole. The top half of this sprocket is made by simply punching out the center of the bottom half stamping. The ball-race sections for the top and bottom sprockets are also both made in the same die. These two pieces are shown in Fig. 3 at *G* and *H*, *G* being the ball-race for the lower sprocket and *H* the ball-race for the upper sprocket. These are formed from steel 5/32 inch thick. On account of the drawing operation, the sides of the cup that comprise this part are much thicker than the bottom—the edge being thickened as the result of the drawing operation. The thick edge, of course, forms the section in which the ball-race is turned. The lower sprocket ball-race has three holes punched in it and also a filling slot punched

in the edge. This filling slot, after the balls have been put in place, is closed by the small spring clip that may be seen at *Z*. Fig. 3, and thus the balls are prevented from coming out of the groove while in action. The upper sprocket ball-race is formed from the same cup as the lower ball-race by punching out the center. In punching out this center, the stock is removed so as to leave the edge in the form of clutch teeth. By referring to the line illustration Fig. 4, the purpose of these clutch teeth will be seen. The clutch is shown at *L*, Fig. 3, and is a plain punching with a lug that is afterward bent up. Two pins are forced into holes that have been punched and an oblong slot in the center provides for a plain in-and-out motion of the clutch that acts in conjunction with the clutch teeth in the ball-race.

The purpose of this mechanism is to provide for the raising or lowering of the sash to any desired point, with the surety that it cannot be pushed open by an outsider or jar out of position. When the handle on shaft *P* is turned, the pinion *O* and gear *R* cause shaft *Q* to turn. As the clutch-cam *M* is anchored to this shaft, it also turns, of course, causing its sides to act on the two pins in the clutch, and giving the clutch a longitudinal movement to disengage the teeth. Continued turning raises or lowers the sash, as the case may be, and when pressure is released from the handle, spring *N* throws the clutch-cam in mesh again.

The spring-case, cam-plate and gear cover are all good examples of press-work, but there is nothing extraordinary in the production methods that are employed. The three gear-blank punchings shown at *R* in Fig. 3 are lined up when assembled on the square section of the sprocket spindle so that the three gears form a composite or sectional gear as shown at *R*, Fig. 4.

Broaching the Teeth on the Pinion

The pinion blank and pinion spindle shown at *O* and *P* in Fig. 3 are, of course, produced on the screw machine, but the forming of the teeth on the pinion blank, leaving it in the condition shown in the illustration, is a press operation, and one that is worthy of description. These gear teeth, ten in number, are formed on the ¾-inch diameter section of the pinion blank by a broaching operation, the piece being finished to the entire depth at one pass of the broach. The fact that the pinion face is one-half inch wide makes this operation of decided interest.

The die used for this broaching operation is shown in section in Fig. 6, and Fig. 7 shows it in place in the press. This illustration is intended to give only a general idea of the tools for broaching these gear teeth, but from it will be seen that the press has an extra long stroke. The punch is fluted for its entire length with grooves corresponding to the gear teeth so that there will be no interference when pushing the gear blank through the die. The die is fitted with a lubricant pipe for supplying oil to the broaching sections of the die. Now, by referring to the line illustration which shows the die in section, it will be seen that it is built up within the heavy casing *A*. A base-block *B* is fitted at the bottom of this casing and four sets of broaching dies *C* are used for cutting the teeth. These broaching dies are separated with spacing blocks *D* at intervals of 5/16 inch; thus the first broaching die measures 0.702 inch at the bottom of the teeth. As the blank is 0.750 inch in diameter, it will be seen that the first die section removes 0.048 inch. The second die section measures 0.638 inch internal diameter, thus removing 0.064 inch additional from the gear teeth. The third section which is 0.528 inch diameter reduces the teeth in diameter

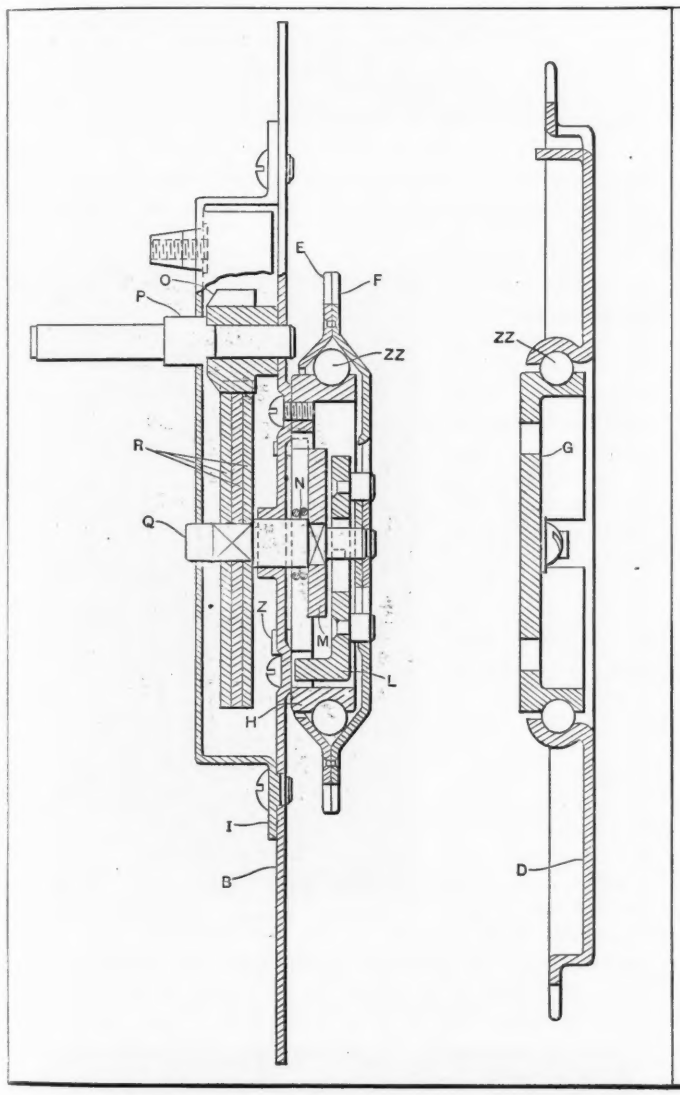

Fig. 4. Sectional View through Upper Sprocket and Gear-box

Fig. 5. Sectional View through Lower Sprocket

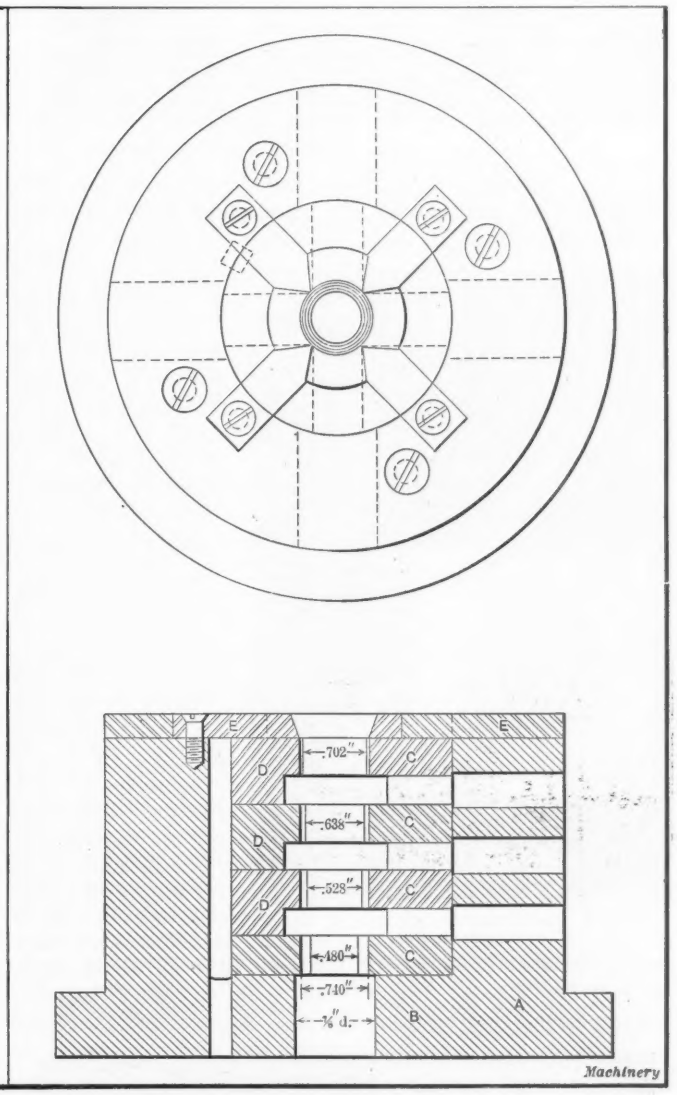

Fig. 6. Sectional View of Broaching Die for cutting Teeth on Steel Pinions

to this size, removing 0.110 inch of metal. The fourth and last section measures 0.480 inch in diameter, reducing the blank by 0.048 inch only; thus the last cut is more of a finishing operation than a metal removing process. A pilot on the punch serves as a locating point for starting the gear blank, and as the sides of the gage strips *E* are slightly beveled, the blank is made to enter the broaching dies straight. This broaching operation is very successful, and the teeth are cut much more rapidly and accurately than could be done by ordinary gear-cutting methods.

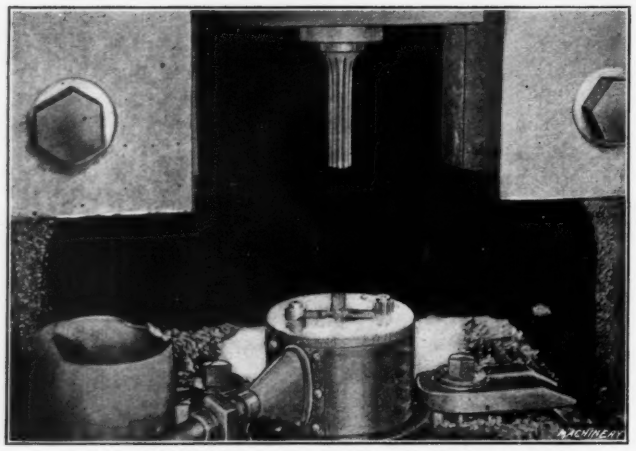

Fig. 7. Gear-teeth Broaching Punch and Die in the Press

Fig. 9. Assembling the Sections of the Thirty-five-tooth Gear

Assembling the Regulator

The assembling operations are shown in Figs. 8, 9, 10, 11 and 12. Fig. 8 shows the assembling of the chain. This is done in a foot press, inserting the rivets through the links and upsetting them sufficiently to keep the parts in place until they can be riveted on a power riveter. In each chain must be correctly located two of the hook links for supporting the spring that takes up the slack and correctly tensions the chain, and also a stud supporter for carrying the stud-roller which works in the cam-plate and acts on the window frame, as has been previously described.

Fig. 9 shows the building up of the thirty-five-tooth gear, using the three punched sections that were shown at *R*, Fig. 3. These are assembled on the square section of the spindle by using a hollow punch in a foot-press. The ring shown before the press has aligning teeth to engage the three punchings and is used for locating the sections when being forced into position so that the teeth will match up correctly.

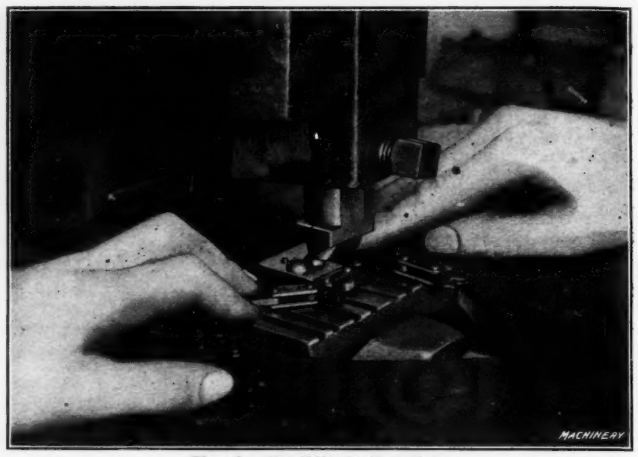

Fig. 8. "Building" the Chain

In Fig. 10 may be seen the assembling operation on a back-plate. The screws are driven into place with an Errington stud-setter, using a screw-driver for this particular job. By this means the screws are all driven to the same tension a great deal faster than they could be by hand. Fig. 11 shows the "running in" of the upper sprocket. In order to insure that this part of the device works successfully, it must be run in so that it is free from all jumpy action or sticking. Here again an Errington stud-setter is employed having a square socket to take the place of the handle. This is used on the end of a horizontal shaft

Fig. 10. Errington Stud-setter used as a Screw-driver

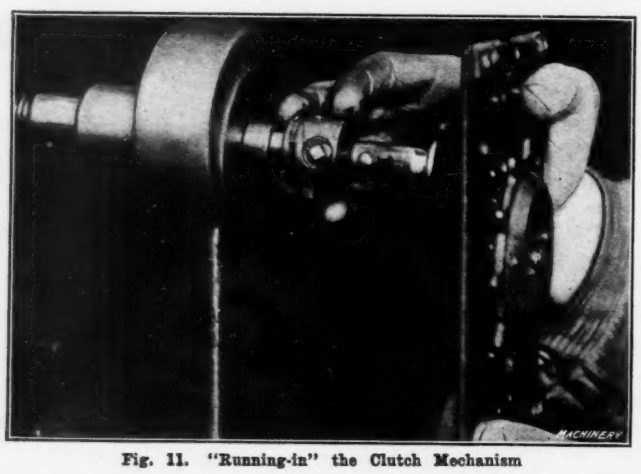

Fig. 11. "Running-in" the Clutch Mechanism

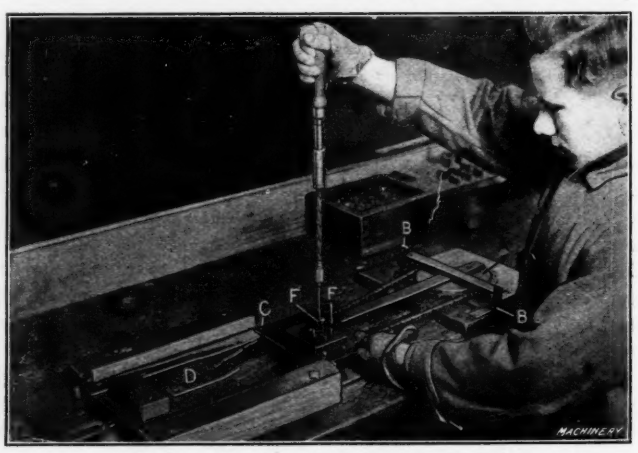

Fig. 12. Adjusting the Tension of the Chain

and any excessive friction causes the stud-setter to slip, thus showing that the part in question is defective.

Fig. 12 shows the final assembling operation; *viz.*, the tensioning of the device. At this time the device has been as-

sembled in two sections: the spacing bar with the lower sprocket, and the back-plate and upper sprocket. It now remains to locate the back-plate and upper sprocket on the spacing bar at the correct distance from the lower sprocket so the chain will operate freely under load. This is tentatively done by two screws in the spacing bar that pass through slots in the back-plate. These slots are about one-half inch long, which gives considerable latitude. The tensioning device is shown in Fig. 12. The spacing bar and lower sprocket, shown at *A*, are held against the brackets *B*. The chain is passed around the sprockets and the back-plate by means of two corner holes located on the slide *D* that is drawn back by the tensioning spring *E*. The spring used is sufficiently strong to give tension enough to counterbalance the weight of the automobile sash and window that the device is to be used in connection with. As soon as the spring has drawn the back-plate to its position, the operator sets up screws *F*, after which he drills and rivets the back-plate to its permanent position on the spacing bar.

This operation completes the regulator and it can now be appreciated that the entire device has been built to the "tune" of a punch-press—no castings, forging or other machined parts being used. It will also be noted that all the way through, as far as possible, simple dies have been used and whenever it was found possible to produce more than one part from the same die by a little change in design, this was done. The simplified design and the elimination of all operations except that of press-working has made it possible to produce this device at a marketable price, and it has been very successful.

* * *

FILING YOUR OWN PATENT—A REPLY

BY A. P. CONNOR*

In the February number of MACHINERY there was an article entitled "Filing Your Own Patent"; there are many inaccuracies in this article. In order to correct the wrong impressions which its publication may have created, the present writer will analyze it, so that the reader may not only be warned of the pitfalls which lack of knowledge may lead him into, but be equipped with that information which will serve to assist his judgment in determining the proper course to take in such matters.

The title itself, "Filing Your Own Patent," is subject to criticism. The writer did not refer to the *filing*, but the *prosecution* of a patent *application*. Hence, the article should have been entitled, "Prosecuting Your own Application for Patent."

[On page 167 of the *World Almanac*, 1914, in a statement revised by the Patent Office, the following appears: "If an inventor wishes to file an application for patent * * *" This would indicate that the expression "filing" is not entirely incorrect in this connection.—EDITOR.]

In the first paragraph of the article in question, it would seem that the previous writer intended to keep on both sides of the matter, first by pretending to discourage the inventor against applying for his own patent, and then advising him to do so, through insinuations that his path would not be so difficult, if he really wanted to try it. The writer evidently thought that some excuse for his article was necessary, as he assigns the ground that "stern necessity may compel the inventor to prosecute his own application for patent." This reason is worth analyzing. When does this "stern necessity" compel an inventor to take the course suggested? The most practical reason which may appeal to many readers is the financial one. It may be suggested that the inventor is penniless, which, however, is seldom a fact, because invention is dependent on industry, and industry keeps a person with some loose change. Secondly, if his invention is valuable and worthy of a patent, can he not get someone to pay the costs of the fees for the patent application, in exchange for an interest in the invention? If not, the case is a very rare one in our present age, when the value of patents is appreciated.

The writer is frequently requested, by persons he knows personally, for opportunities to get an interest in good inventions. Almost anyone would risk the moderate cost necessary in patent matters for a chance to make a substantial fortune out of it. Then, again, an attorney will usually be reasonable in pressing financial matters on his clients, so the inventor will not be unduly embarrassed. Can anyone of intelligence imagine a case where it would be advisable for an average inventor, or even a person of exceptional ability, who is inexperienced in patent matters and practice, to prosecute his own application, and expect to be as amply protected as his invention merits?

We are further informed that "it is a notorious fact that there are a great many incompetent patent attorneys." The statement is so serious that it seems hardly possible to believe that it could be made with such *sang froid*, and the late writer should either prove it or withdraw it. A copy of any proofs in the matter should also be submitted to the Commissioner of Patents for appropriate action.

[On page 167 of the *World Almanac*, 1914, in a statement revised by the Patent Office, the following appears: "The Patent Office cannot recommend any particular attorney or firm, but advises applicants to avoid doing business with those who advertise the possession of unusual facilities for obtaining patents."—EDITOR.]

The present writer may incidentally say that the registration of patent attorneys is a very strict matter at the present time, and the requirements are severely enforced. Assume, for an argument, that the statement is true that we have incompetent attorneys. The inventor is advised to prosecute his application even though he does not know what he is doing, but he is warned to keep away from incompetent attorneys. It would seem that an application for patent would be safer in the hands of the most incompetent attorney, because he must know *something* about what he is doing, rather than in the hands of an inventor who knows absolutely *nothing*.

We are further informed "that most patents are valueless because they have no real invention behind them." Surely the country would like to have the authorities and proofs supporting the statement. However, the courts sustain the patent practice, all inventors of ability and consequence patronize the Patent Office, and the examiners have to pass the strictest examination in the whole civil service and are in addition usually trained as lawyers. All corporations, capitalists and other persons interested in patents will not consider inventions without patents protecting them. Have all these been fooled? Has all our industrial progress, and the fortunes made on patents been the outcome from inventions with no real invention in them? If the original writer has the key to the identification of valuable invention, which has been overlooked by everyone except himself, now is his opportunity to enlighten the world.

[In 1909, the *American Machinist* investigated the matter of how many patents paid back their own cost and found that only twenty-three patents out of a hundred paid their own cost. Note that this does not imply a profit, so that while it is not known how many of these twenty-three were actually profitable, it was certain that in the hundreds of cases covered, seventy-seven out of one hundred did not pay their own cost. This investigation carefully carried out under reliable auspices seems to give some strength to the statement of the former writer that most patents are valueless.—EDITOR.]

As to the suggestions for selecting an attorney: We are told that attorneys should "have built up a reputation over a long period of years, and be known to prominent attorneys, bankers and business men." Evidently the question of ability, technical training, energy and actual results are not worth consideration, nor would a young struggling conscientious attorney be considered. Yet, if the advice was made use of and it was found that the prominent attorney had turned the case over to an employe, and that the former in fact never saw the invention at all, what would the prior writer say, even if the original attorney has all the qualifications given? The writer has known of several instances where it proved more dangerous to make use of attorneys with reputation than the more mediocre ones, because of the fact that the former gave very few of the cases their personal attention. Therefore, the suggestions are by no means adequate, but rather misleading, especially to the inventor with more ability than money.

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MAKING FORMED CUTTERS*

MACHINING THE FORMER AND MASTERS, FORMING THE BLANK, AND CUTTING AND RELIEVING THE TEETH

BY F. B. JACOBS†

Milling cutters of irregular shape that can be sharpened without altering their contour, an example of which is shown in Fig. 1, are generally called formed cutters. They are used for milling irregular surfaces on gun and sewing machine parts and on other work of like nature. Perhaps the first formed cutters to be commonly used were the gear-cutters known to every mechanic. Satisfactory formed cutters can be procured from any cutter manufacturer at a moderate cost, but as several weeks often elapse before special cutters are delivered many shops are equipped to make their own cutters.

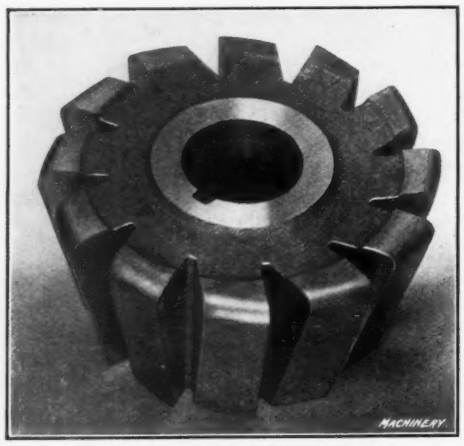
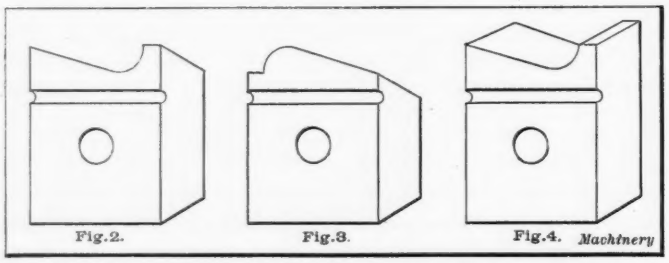


Fig. 1. A Typical Formed Cutter

In explaining the various steps in the making of a formed cutter we can use the tool illustrated in Fig. 1 as an example. As this is a male cutter it is formed and backed off with the female former shown in Fig. 2. As this former has to have a clearance of at least 15 degrees, with the original lay-out accurately preserved, it is necessary to form it at an angle by means of the master shown in Fig. 3. As this master has a convex surface that would be difficult to work out accurately by hand, a second or female master is made. This is shown in Fig. 4, and it is an exact counterpart of the shape we wish to mill worked out in a block of steel without any clearance. This piece is hardened and drawn to a medium straw color.



Figs. 2 to 4. Former and Male and Female Masters for producing Formed Cutters

To make the masters and former without distorting the contour, and at the same time give the former the necessary clearance, the angle block and tool shown in Fig. 5 are used. The angle block is strapped to the platen of the shaper and the female master is fastened to the angle tool. First, however, the outline is worked to shape as near as possible with regular tools, the female master being used only for finishing. As the illustration shows, it works with a drag cut which necessarily means slow procedure. It will also be seen that the faces of the two masters are parallel; this is why the proper contour can be maintained, notwithstanding the fact that clearance is imparted to the male master. This master is now hardened and drawn and the same process gone through with in making the female former.

The masters and former are sharpened by grinding their tops or faces. The slight groove shown is for the corner of the wheel to run into. They should be sharpened on the surface grinder, as their faces must remain flat; otherwise the contour will be changed. In finishing the master and former on the angle block, it is necessary to use a very slow cutting speed to avoid chattering. As a very smooth surface is desired, good lard oil should be used as a cutting medium.

Formed cutters can be made of bar stock chucked out and turned up in the usual way. About 0.003 inch should be left in the hole for finishing by grinding after hardening, and it is a good plan to relieve the sides as shown in Fig. 1, as this eliminates a certain amount of unnecessary grinding. The hole should be chambered and provided with a keyway. The form is turned on the cutter with the former previously made. This is done in the lathe, the former being fastened to the tool shown in Fig. 6. It is seen that both this and the angle tool are made on the goose-neck principle to obviate chattering.

The cutter is now ready for cutting or scoring. This is generally done with a 30-degree angular cutter rounded at the point. Before cutting, it is a good plan to drill holes as shown in Fig. 7. This leaves a slight clearance for the corner of the wheel to run into during the grinding operation. After this operation is finished, the cutter is ready for relieving, or as it is more commonly called, backing off. There are several appliances for this purpose in the form of attachments for the lathe and milling machine. The device shown in Fig. 8 is simple to construct, easy to set up and it gives very good results. Briefly described, it consists of a sliding base mounted in a bed that is strapped to the milling machine platen. A strong spring thrusts the base toward the spindle and cam. The cam is mounted on a cast-iron holder that screws onto the nose of the spindle, while the cutter is mounted on a stub arbor. The former, shown in Fig. 2, is fastened to a sliding head that is actuated by a screw. This regulates the depth of cut in backing off the cutter. The details are shown in Fig. 9, which illustrates an end elevation and longitudinal section. As each cam has a fixed number of teeth, three are generally provided for cutters with ten, twelve, and fourteen teeth, respectively. It is very necessary that these cams be accurately made; otherwise faulty cutters will result. The method employed in laying out and machining will be explained later.

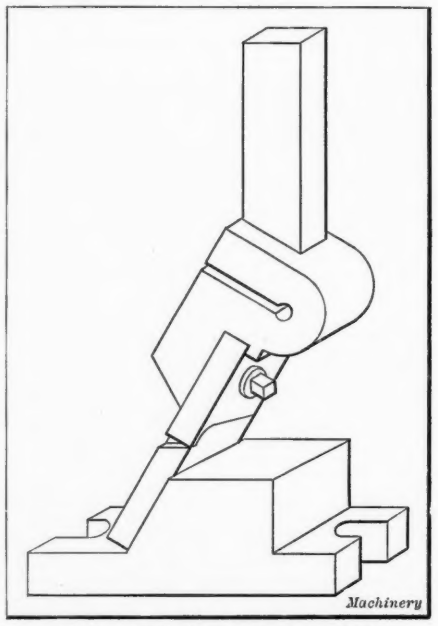


Fig. 5. Angle Block and Tool used for making the Former and Master

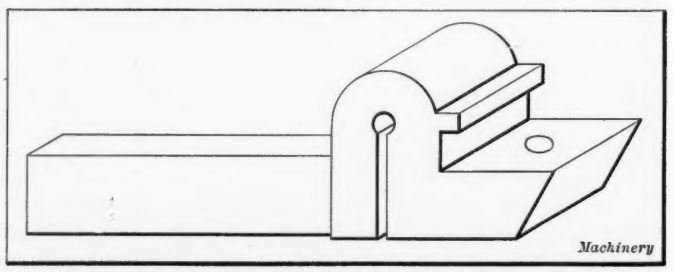


Fig. 6. Gooseneck Tool-holder on which Former is mounted for machining Formed Cutters

In setting up for the backing-off operation, it is necessary that the cutter be set so that the teeth are in the correct re-

* For additional articles on formed cutters and allied subjects, see "Importance of Grinding Gear Cutter Teeth Radially" published in MACHINERY, July, 1907; "A Formed Tool Problem," January, 1910; and "Milling Radial Teeth in Cutter Blanks," November and December, 1911, and other articles there referred to.

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lation with the corresponding cam rises. To this end, an arbor without a tang is used. A line is scribed on the cam meeting the high points of two rises that are opposite. The arbor is placed loosely in position, the cam set central by means of the scribed lines and a surface gage, and the arbor adjusted so that the cutter tooth does not meet the former within 1/16 inch. The arbor is now driven solidly into position. The object of the 1/16-inch leeway is to make sure that the former is moving toward the cutter before the tooth is reached.

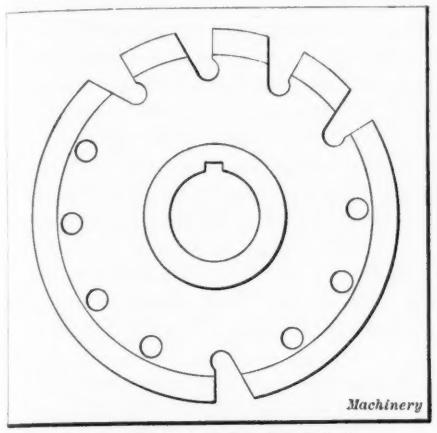


Fig. 7. Holes drilled in Blank before cutting Teeth

In backing off, a very slow speed should be used and the work should be lubricated with lard oil. Light cuts should be taken, as heavy cuts are likely to leave scores which result in unsatisfactory work on the part of the finished cutter. After the teeth have been backed off, the former should be reground and the top whetted on an India oil-stone wet with gasoline. It should be examined under a glass to make sure that it has a clean sharp edge without scores. It is then placed in position again and a light finishing cut taken. It is necessary that the top of the former be set central with the cutter, for if it is above or below, an incorrect contour will be formed.

The cutter is now hardened and drawn in the usual way. After hardening, the sides should first be ground. A Heald

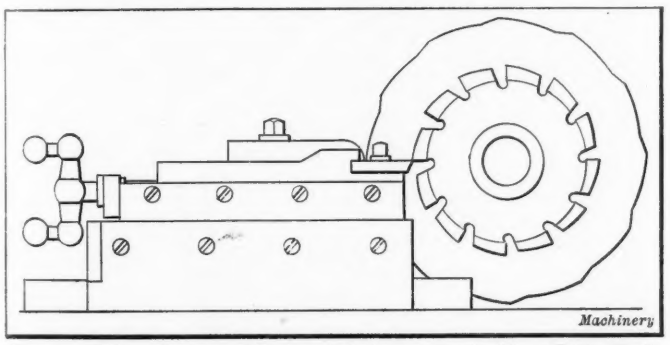


Fig. 8. Milling Machine Relieving Attachment for backing off the Teeth

piston-ring grinder is an excellent machine to utilize for this purpose, but if one is not available the universal grinder can be used. After grinding the sides, the cutter is strapped to the faceplate of the grinding machine, the hole trued up with an indicator and ground to the desired size. The next operation is to grind the faces of the teeth. While this is a simple operation, care should be exercised to see that the teeth are equally spaced, for while they probably were equally spaced after cutting, the hardening process may have distorted them

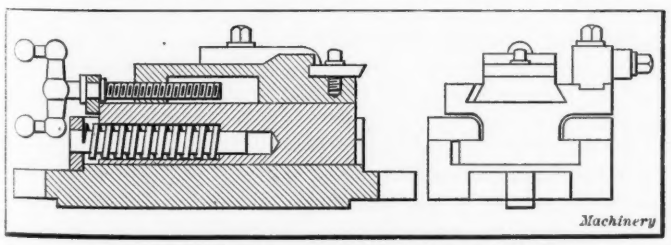


Fig. 9. End Elevation and Sectional View of Relieving Attachment shown in Fig. 8

slightly. This grinding operation was fully described in MACHINERY, February, 1912.

As previously stated, the cams for relieving the teeth should be accurately made, and the most simple and efficient way is as follows: The cam plate is first chucked out to fit the mandrel *A* shown in Fig. 10 and the sides and periphery turned in the usual way. The hole is then plugged up, as this space has to be utilized in laying out. This lay-out is illustrated in Fig. 11. First one actual sized cutter tooth is drawn or rather scribed, as shown, the object being to determine the pitch of the clearance. It is necessary to have enough clearance to allow the cutter to take hold of the work; and at the same time, if too much is allowed, short-lived cutters having a tendency to chatter will result.

A good practical way to determine the correct amount of clearance is to use as a guide a formed cutter made by a reliable cutter manufacturer. Set this cutter central on the

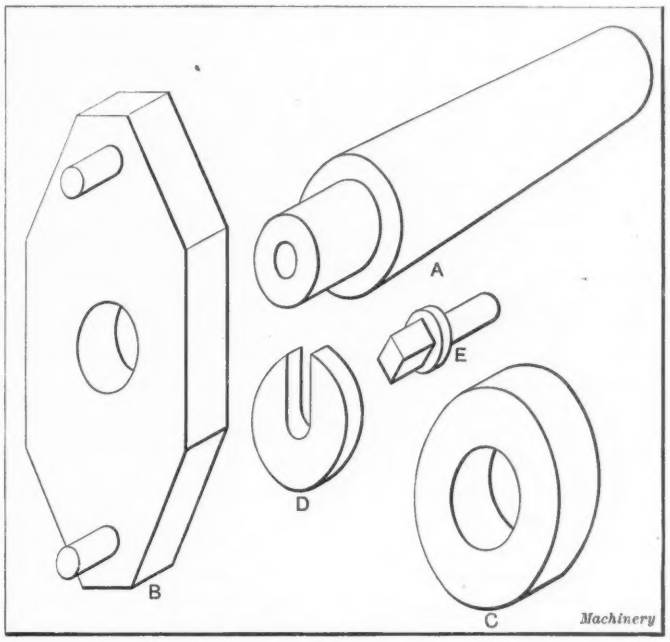


Fig. 10. Tools used in machining the Relieving Cams

cam blank and carefully scribe the clearance line. This line is nothing more nor less than an arc set off center. With a pair of dividers, find the center and mark it with a center-punch mark. This center is shown at *B*, and the line of clearance at *C*. From the center *B* the arc *D* is scribed, which gives the same relation between the points *E* and *F*. The 30 degrees in the arc *G* represent one tooth. To make sure that the former will not start to return until the complete tooth has been gone over, and also that it will be ready to start cutting as soon as the next tooth strikes it, the time of return is confined between the lines *H*. Next the circle *J* is laid off. It is seen that this connects the lowest point of the stroke with the beginning of the next stroke. The center of this circle is carefully center-punched.

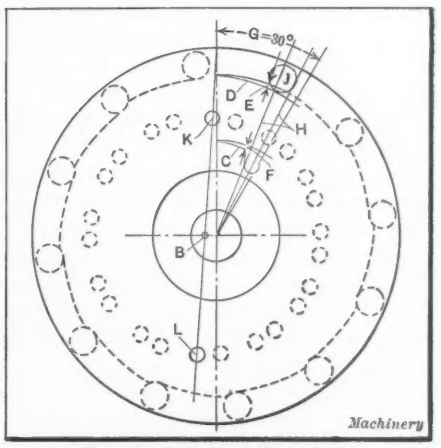


Fig. 11. Layout of One of the Relieving Cams

The two holes *K* and *L* are next laid off, and the centers punched. There are twenty-four holes altogether, two for each tooth. These are used for locating the cam while machining the rises. Before doing this, it is necessary to be provided with the tools shown in Fig. 10, where *A* is a mandrel to fit the milling machine dividing head, and *B* is the locating piece, the hole in this locating piece being a driving fit over the mandrel. Before using this piece, however, it is necessary to finish the twenty-four small holes, also the twelve large ones in the cam blank. This is done in the milling machine, the dividing head being used for spacing the holes. The head is set at right angles with the platen, its center being on a plane with the milling machine spindle.

The cam blank is placed in position on the special mandrel with the collar *C* back of it. This collar is used simply to

fill up the space that is later occupied by the piece *B*. The screw and washer *E* and *D* are used in clamping the cam blank. The punch mark for the hole *K* is carefully centered, after which the hole is drilled, trued up with a boring chip and then reamed. The dividing head having previously been set for twelve divisions, the remainder of the holes corresponding to *K* are finished. Next the center for the hole *L* is located and all the holes in this circle finished. These holes are shown by the small dotted circles in Fig. 11. It is evident that these holes finished in the manner described will serve as an accurate means for locating the blank while machining the rises. Next the hole *J* is located, drilled, bored and reamed. As this is comparatively heavy drilling to do in the manner described, the superfluous stock can be drilled on the upright drill. The piece is then replaced in position on the milling machine and the holes bored and reamed. The center hole is now indicated and bored in the lathe to the correct size to fit the cam back.

By referring to the piece *B*, Fig. 10, it is seen that it has two holes in a line with the center. These holes are supplied with dowels. It is evident that when the holes *K* and *L* in the cam blank are slipped over these dowels, the arc *D* is thrown in a position where it can be machined as part of a circle. This is done in the shaper, the dividing head being used for the purpose, the cam blank and the piece *B* being held on the special mandrel. After planing one rise as shown by the dotted lines, the piece is moved into position for the next rise, and so on until all are gone over.

In the final finishing, all the rises are gone over one after the other with a very light chip, the set of the tool not being disturbed. It is very necessary for all the rises to be alike; otherwise, cutters with uneven teeth would be the final result. For this reason, after the final finishing chip has been started it should be continued, for if the shaper should be allowed to remain idle for a time—say over noon hour, or what would be worse, over night—some rises would surely be higher than others. Three of the holes can be used for dowels in locating the cam on its back, while three more can be countersunk and used for screw holes. The cam should be made of tool steel and it should be hardened in cyanide and oil, as any other hardening process might distort it.

* * *

A NEW FIELD FOR THE OXY-ACETYLENE CUTTING TORCH*

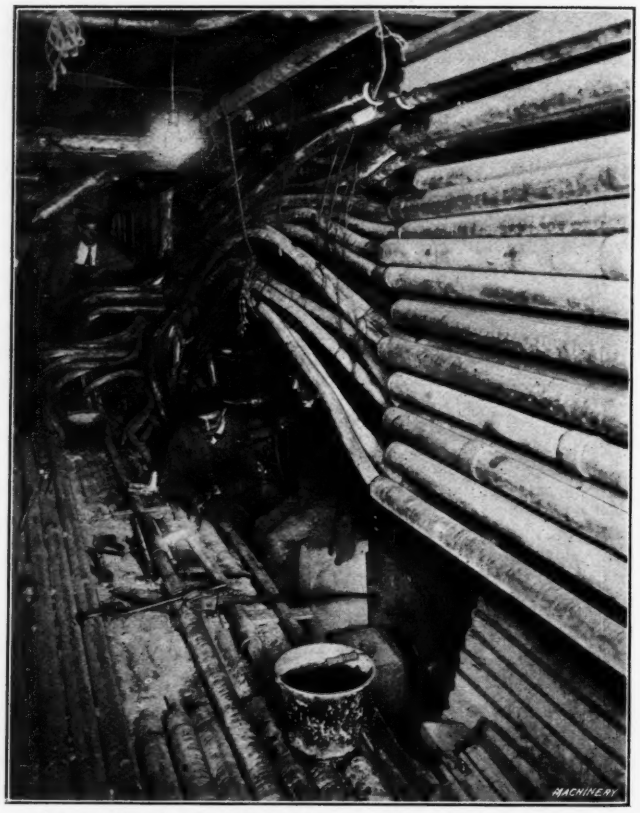
BY GEORGE G. PORTER†

A new field for the oxy-acetylene cutting torch is shown by the accompanying illustration which was taken in the basement of the Warren Telephone Exchange at Syracuse, N. Y. The underground lead cables carrying all of the wires from the city 'phones into the exchange, entered from the street first into a manhole which extended underneath the sidewalk to the wall of the building, and from there to the exchange room the cables were encased in three-inch iron pipes. After the consolidation of the two telephone companies in Syracuse, and the consequent increase in the number of cables coming into this exchange, the manhole soon became very much congested, which made an enlargement necessary. This was effected by removing a portion of the wall of the building and extending the manhole back into the basement a distance of about fifteen feet.

After the wall was removed it was necessary to also remove the iron casings from the lead cables so that they could be bent and re-arranged to make room for the new ones. This looked like an almost insurmountable task, as there were about eighty casings in the two tiers, over half of them containing cables, and to remove them by cutting off with hammer and chisel would have been an almost endless job, and practically impossible, as the pipes were so close together that swinging a hammer would be very difficult, and then too the noise would be transmitted through the pipes to the entire building—a most objectionable feature. It was suggested that a special machine be built which would mill slots in the sides of the casings, and then saw them around so that they could be removed, but this was also abandoned on account of the lack of room in which to operate it.

Finally the Porter-Cable Machine Co. of Syracuse was consulted about the job, and after looking it over a decision was made that it might be possible to cut off the iron casings with the oxy-acetylene cutting torch without damaging the lead cable underneath. This too seemed like an impossible thing to do, as the melting point of lead is about 600 degrees, while that of wrought iron is about 2300; and the oxy-acetylene flame has a temperature of over 6000 degrees. However, a piece of the cable and casing was obtained to experiment on in the shop. The first experiments were failures, as the lead was melted almost instantly, but a plan was finally developed, and special appliances were made, consisting of guides for the torch and semicircular copper shields to slip in between the cable and the casing. After a few trials this plan seemed to be so successful that the Porter-Cable Machine Co. was awarded the job of removing the casings. The job was handled as follows:

A copper shield about two feet long was slipped in between the cable and casing, then the casing was cut around with the



Oxy-acetylene Torch being used for cutting away Iron Armor of Lead covered Telephone Cables

torch for a short distance and at a safe distance from the inner end of the shield, so as not to allow the flame to come too near to the lead cable; the casing was then rolled over a small amount, the shield re-adjusted and another cut taken. This was continued until the casing was cut all the way around; it was then slid back on the cable and split in two lengthwise, allowing the pieces to be removed. The reason for making the shields of copper, was that the oxygen cutting jet will only cut wrought iron and steel, and does not have any cutting effect on copper.

At the time the photograph was taken, about half the casings had been removed, those on the floor tier still remaining to be done. As it was necessary to make two cuts lengthwise to allow the short pieces to be removed after being cut off, and as the circumference of the casings was about eleven inches, the total length of the cuts made by the torch was about 1500 feet.

The cables were practically uninjured, there being two small holes melted in them during the entire job. This was at the commencement before the operator had become thoroughly familiar with the requirements. This is believed to be the first time this kind of job was ever attempted.

* For articles on oxy-acetylene welding and cutting previously published, see "Machine for Making Welded Seamless Tubing," October, 1913; "Preheating Metals to be Welded by Oxy-acetylene Process," October, 1912; and other articles referred to.

† Address: 230 South Ave., Syracuse, N. Y.

LETTERS ON PRACTICAL SUBJECTS

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FEED CHUTE FOR DRAWING PRESS

Figs. 1 and 2 illustrate the application of an interesting form of feed chute that is used to prevent the breakage of drawing punches. The press on which this device is used is employed in performing a drawing operation on the cups shown in the illustration. These cups enter the chute *A* from a hopper and pass down at high velocity; when the bottom of the cup strikes the pin *B* the cup rebounds and drops into the feed-pipe *C*, which leads to the feed fingers of the press.

It is necessary to have the cups feed into the press with the closed end down, as shown in Fig. 1. It sometimes happens, however, that a cup enters the chute *A* in an inverted position, as shown in Fig. 2. If the cup reached the die in this position, it would result in breaking the drawing punch. Fig. 2 shows how this is avoided. The cup enters the chute *A* and slides down until it catches on the pin *B*. Thus it cannot rebound, but swings on the pin *B* and drops into the feed-pipe *C* with the closed end down in the manner illustrated. This device is carried by a bracket which is attached to a stationary part of the press.

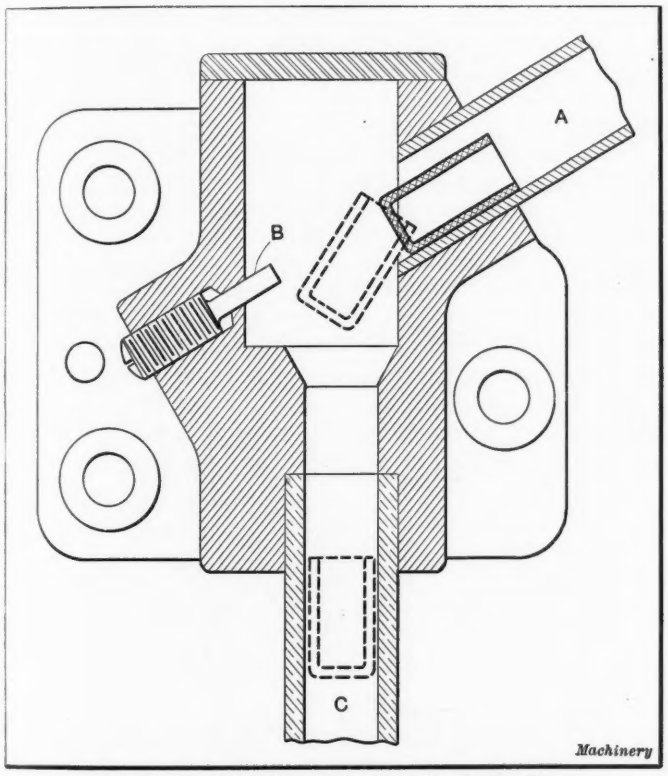


Fig. 1. Cup delivered to Feed Pipe C in Regular Way

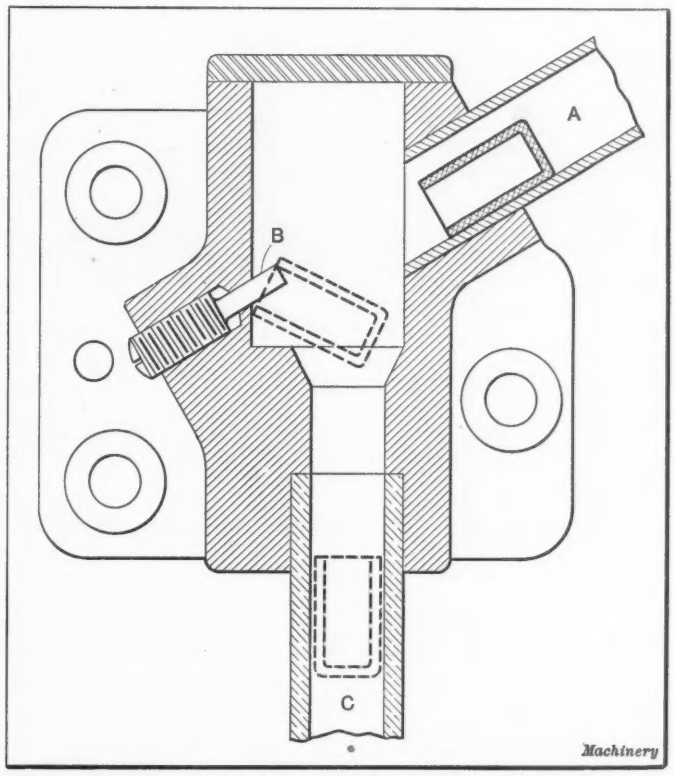


Fig. 2. Inverted Cup in Act of turning over before entering Feed Pipe

LAWRENCE FAY

BOOK AGENTS AND APPRENTICE BOYS

There are men calling themselves book agents who travel through the country visiting shops and factories. In reality, these men are nothing but "leeches" who prey upon the ignorance of the average shop hand or apprentice. I have had a good deal of experience with these so-called publisher's agents, and find that in most cases they pick apprentice boys for their victims and sell them several massive volumes full of old wood cuts and manufacturers' engravings. To do this they "hand out a line of talk" that throws the dust in the boys' eyes, with the result that they buy costly set of books that are probably never opened after a cursory inspection of the pictures is made. In most cases the books consist of from two to four volumes, costing $15 to $25 for the set. The binding is attractive, but the books are altogether too heavy for a shop man to carry in his tool chest to refer to when in need of information. There are few shops where shelves are available to keep such books and in most cases there would be a row if an employe was seen opening a book weighing from ten to twenty pounds during working hours.

The main objection that I have to the book agent is the method that he uses in making a sale. He usually starts in by telling his victim that Mr. Bank of Blank & Co. bought a set of these books when he was only making $12 a week and that he is now earning $5000 a year and owes it all to the information he obtained from his set of books. Mr. Blank is further quoted as having stated that he would not be without a set of these books at any price. This usually is the means of making a sale. In a certain case that came to the writer's attention, an apprentice boy happened to mention that his grandfather had bought a set of the first edition of a certain work. This was the agent's cue. He asked the grandfather's name and immediately said that he remembered having sold him the books in question but that the first edition was now entirely out of date and the apprentice should have books giving information concerning the most modern practice. This boy bought the books in question for $25 and offered to sell them three weeks later for $10. He was a boy of average intelligence, and if he had been given time to look into the matter he would have seen that he was paying an exorbitant price for something from which he would get little benefit. He was simply carried away by the agent's arguments and that is the way in which most valueless books are sold.

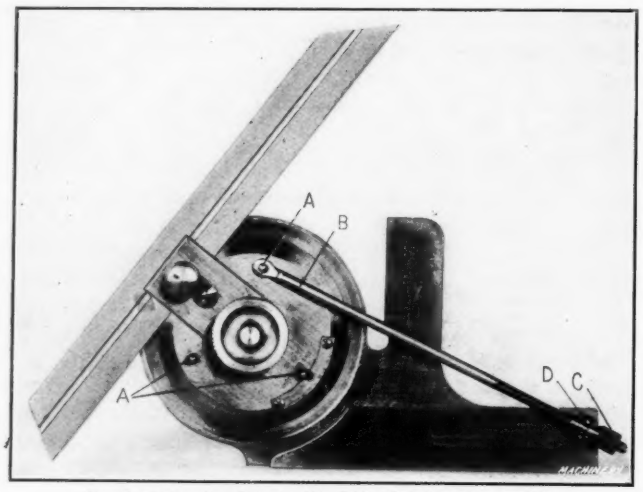
I think that a satisfactory remedy for this state of affairs would be to have the superintendent of a factory or some other man of sound judgment take a little more interest in the employes' welfare. If book agents were refused admission to a shop without first leaving copies of the books they wish to sell at the office to be looked over with the view of determining the value of the information contained in them and the fairness of the price, a lot of this trouble would be eliminated. It is generally quite easy for an agent to deceive an inexperienced apprentice boy, but it would be another matter if he had to convince an older man of the merit of the books he was selling. If such a course of action were followed, an agent could be granted admission to the shop after his book had been O. K.'d. The foregoing must not be

regarded in the light of a criticism of shop agents of reputable publishers, as the books and magazines issued by such firms are certainly of the greatest value to every shop man.

Newark, N. J. G. W. JAGER

BEVEL PROTRACTOR ADJUSTING BAR

The following describes an adjusting bar for use on the B. & S. bevel protractor. This bar can be easily made by any toolmaker to suit the protractor which he uses, and will be found of value in making accurate adjustments. When not in use, the adjusting bar can be taken off. Referring to the illustration it will be seen that three pins *A* are driven into the movable disk 120 degrees from each other. These pins are made of drill rod 3/32 inch in diameter and are located



Bevel Protractor fitted with Adjusting Bar for making Accurate Settings

¾ inch from the center of the disk. The adjusting bar *B* is also made of 3/32 drill rod, which is flattened at one end and drilled to receive one of the pins *A*. The opposite end of the adjusting bar is threaded to receive the adjusting nut *C*. A swivel-bracket *D* is attached to bar *B* by means of two lugs which are bent over the nut. This bracket can also be readily removed when the adjusting bar is not required.

Chicago, Ill. H. E. THIELBERG

TAR CONCRETE FOR FACTORY FLOORS

At the last gas congress in Marseilles, France, a paper was read by Mons. D. Hedde on what he considered a new and very practical floor for machine shops and factories. This floor is not only proving resistant to the usual mechanical wear and tear in machine shops, but is also easily cleaned and not quickly soiled, and has the further merit that it is cheap to lay and to maintain in good condition. The mixture consists of 95 parts by weight of stone dust and 5 parts of tar, mixed by hand or by machine according to the amount to be made. Of course machine-mixing is cheaper and more thorough than hand mixing.

Care must be taken that the 5 per cent proportion of tar is not exceeded, as in such a case either the mixture would not harden sufficiently at ordinary temperatures, or it would get soft in hot weather or under the influence of artificial heating. In laying this floor-covering it is not necessary to see that the under-flooring is perfectly smooth or even perfectly level; only to be sure that there are no great bumps or hollows. The earth is first well tamped in order to give it sufficient resistance to enable it to support the tar and stone layer; then about two inches of the mixture is applied, tamped down firmly and made level.

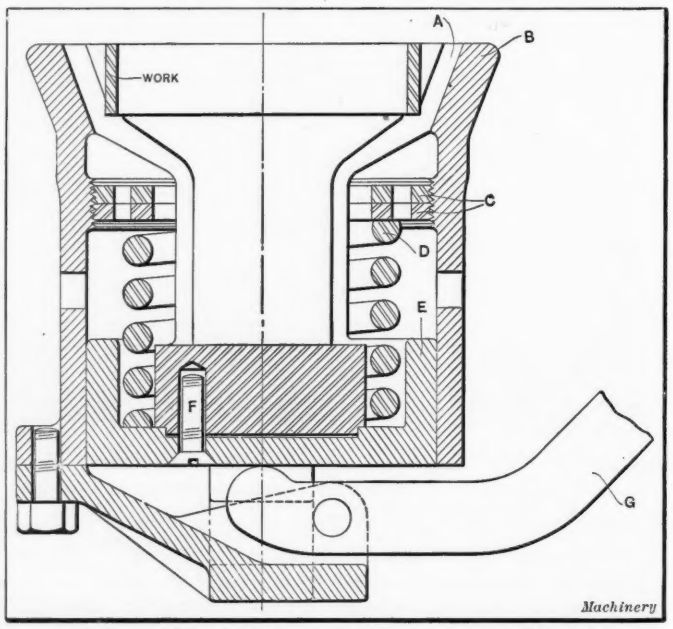
Mons. Hedde says that this floor-covering gets tougher and harder with time, but that during the first month it is desirable to protect it against very heavy weights on small areas. If it is necessary to hasten the hardening process, the floor can be strewn with powdered lime. As regards the cost, European figures have but little value for Americans; but for a floor five centimeters or say two inches thick, the cost is given as 8 centimes or 1.6 cent per square meter, which is about 1.38 cent per square yard. The amounts of material are, however, useful in calculating for American conditions. They are, respectively, 34 and 67.5 kilograms per square meter for the above named thickness; and this would come to nearly 64 pounds and 125 pounds, respectively, per square yard.

Dresden, Germany. ROBERT GRIMSHAW

FIXTURE FOR HARDENING STEEL RINGS

The accompanying illustration shows a fixture which has proved very successful in hardening steel rings of thin section. It is particularly important for these rings to be hardened without distortion, and it was to attain this end that the fixture was designed. Referring to the illustration it will be seen that the sliding member *A* is bored to exactly the required size to receive the work. This member is slotted to make it the equivalent of a spring chuck or collet, and then hardened and tempered. The body *B* of the fixture is made of cast iron and is threaded to receive the two adjusting nuts *C*. The function of these nuts is to regulate the tension under which the spring *D* works. It has been found that the best results are obtained by so adjusting the spring tension that it is proportional to the cross-section area of the work. The ring *E* serves as a bottom guide for the chuck, and also takes the thrust of the spring. Three screws *F* are used to hold the chuck *A* to the ring *E*.

The fixture is carried by a pivot on the edge of the tank containing the hardening bath, and is operated by the lever *G*. This lever compresses the spring *D* and opens the chuck so that the work may be put in place. When the lever is released the chuck is closed by the tension of the spring *D*, and the whole fixture is then turned on the pivot to immerse it in the bath. After the work has been quenched, the fixture is tilted back and unloaded by reversing the process. It will be



Fixture used in hardening Steel Rings to prevent Distortion

seen that recesses are cut in the chuck to provide space to get hold of the work when it is being removed. It must be clearly understood, however, that the chuck grips the work all the way to its upper edge except at the points where the recesses are cut. It will also be noticed that holes are drilled in the side of the body *B* of the fixture so that there will not be any air pressure to overcome.

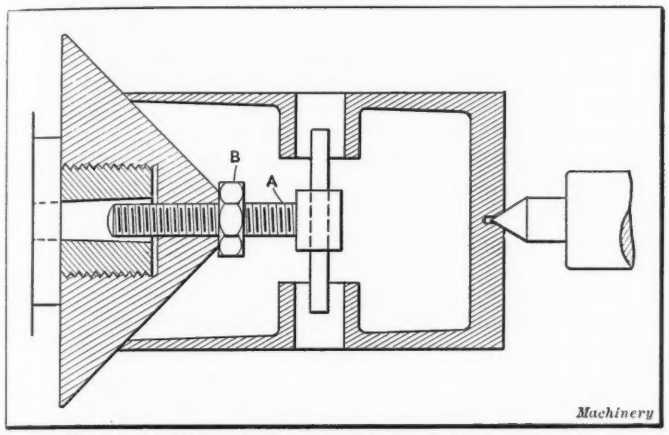
Bristol, Conn. FREDERICK A. HOTCHKISS

METHOD OF HOLDING AND DRIVING GAS ENGINE PISTONS WHEN TURNING

The accompanying illustration shows a fixture that will be found useful, principally in repair shops, for turning gas engine pistons. The open end of the piston is supported by a cone having an included angle of about 90 degrees, which is

screwed onto the nose of the lathe spindle. The diameter of the cone base, in this instance, is 9 inches. The other end of the piston is held by the tailstock center. Screw *A*, which is ⅞ inch in diameter, is screwed into the end of the cone. It is about 3½ inches long and has a square head 1¼ inch wide with a ½-inch hole drilled through it. A rod is driven through the head, which is long enough to engage the wrist-pin bosses inside the piston. The driver *A* is adjusted for pistons of different sizes by means of lock-nut *B*.

Before the piston is placed in this fixture, it should be chucked so that the end can be faced and chamfered where



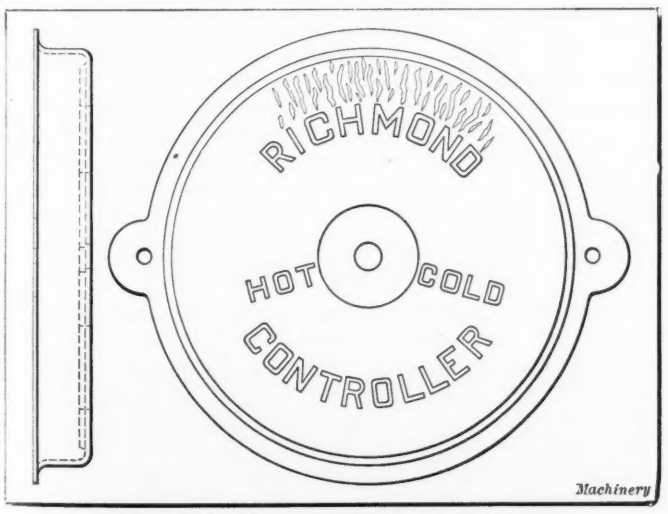
Method of holding and driving Gas Engine Pistons when turning

it bears on the cone. The center for the tailstock end can be put in on a drill press after the opposite end is faced square.

Dubuque, Iowa E. J. BUCHET

WHY THE BLANKS WRINKLED

In blanking and forming work in a combination cutting, forming and embossing die, trouble was experienced after about three thousand good blanks had been finished. At this point the work suddenly started to wrinkle badly at a point



Embossed Work that caused Trouble by wrinkling over Word "Richmond"

above the word "Richmond" and the metal in the letters of this word also seemed to be crushed. This state of affairs developed all of a sudden and without any perceptible cause. The die was taken off the machine and sent to the toolroom for repairs. It was thoroughly overhauled, and as everything appeared to be all right it was returned to the press department. The press was set up and started again but the work showed the same defect that it had before the die had been inspected.

About this time the assistant press foreman came along and the trouble was explained to him. He picked up one of the blanks, looked at it closely and then told the press operator to clean the stock thoroughly in order to remove oil and grease. This was done, and when the press was started on stock which had been carefully cleaned the work was found to be perfect. The foreman told us that the oil had caused the trouble by taking up sufficient space between the punch and die to cause a deformation of the work. This may be a matter that has come to the attention of some of MACHINERY'S readers, but I think that the majority of them have not been confronted by this particular problem.

New Britain, Conn. W. C. BETZ

GAGE FOR U. S. S. THREAD TOOLS

Away back in the days when the form of thread which we now call the U. S. standard was but little known, a machinist received instructions to design and make a gage for grinding the thread tools. To understand the difficulty of the task, we must remember that he had but one of the precision tools which now seem so indispensable, *viz.*, a one-inch micrometer of the old type with exposed thread and beveled points. The only machine tools available were a lathe and planer.

After much cogitation he decided to utilize the wedge principle and evolved the arrangement shown in Fig. 1. The upper edge of the movable scale *A* rests against the two buttons *B* which are adjusted to locate the lower edge of the scale at right angles to the axis of the 60 degree vee. The scale is tapered at such an angle that a movement of 1/32 inch corresponds to 0.001 inch in the width of the exposed edge representing the width of the thread tool flat.

Fortunately, the machinist referred to knew enough about

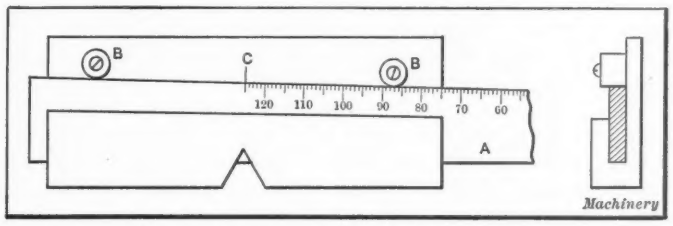


Fig. 1. Gage for U. S. Standard Thread Tools

trigonometry to know how this angle must be calculated, and he could use logarithms so that no lengthy figuring was necessary. He soon determined that the angle must be that whose logarithmic sine is 8.44268, for as 1/32 sin α 2 tan 30 degrees = 0.001

$$\sin \alpha = 0.016 \cot 30 \text{ degrees.}$$

8.20412	Log 0.016
0.23856	Log cot 30 degrees
8.44268	Log sin α

The gage was now complete, *on paper*. The machine steel body was made on the planer. The sides of the vee were casehardened and lapped to fit a 60-degree center-gage, but how could the taper scale be ground in the lathe to the proper angle?

A piece of flat stock was lapped to 0.1875 inch thickness, to use as shown in Fig. 2. Dividing 0.1875 by the sine of α, gave 6.765 + or about 6 49/64 inches as the distance from the end of the straightedge to the point of contact with the 0.1875-inch block. By this means the compound rest of the

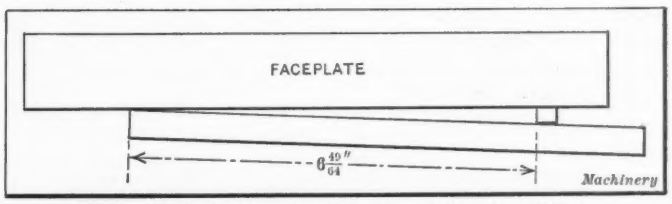


Fig. 2. Method of locating Scale for grinding One Side to Required Taper

lathe was set at the desired angle with the faceplate. The blank was clamped to the tool-block, parallel with the faceplate and was ground with an emery wheel carried by the live spindle.

The scale was easily graduated by a method in common use at that early date. The surface was first covered with asphaltum varnish. The scale was then clamped to the tool-block and the graduations were scratched by a scriber point held on a bar between the lathe centers, the necessary tra-

verse of 1/32 inch being obtained by turning the lead-screw to which a gear was attached to serve as an index plate. After the figures had been scratched with a scriber, the rest of the scale received a coat of asphaltum and it was then immersed in etching fluid.

The gage was then assembled and its zero point *C* determined. This could easily be done now, by using a size block, but nothing of the kind was then available. Even the 3/16-inch piece used to get the angle did not have square corners that were accurate; hence, the only way was to insert a round piece in the vee and determine by calculation what the reading of the gage should be when the scale was in contact with this size plug. A knurled head screw (not shown in Fig. 1) was used to lock the scale when desired.

This gage did excellent work, being as accurate and convenient as the well made and expensive tools we find in the shops at the present time. A similar gage can be made for Acme and worm thread tools, making the vee 29 degrees and tapering the scale to the angle whose logarithmic sine is 8.79146.

For either 60-degree or 29-degree tools, the gage can be designed to give 1/16-inch instead of 1/32-inch movement for 0.001 inch increase in width of tool point, the only objection being the greater length of scale required.

New London, N. H. GUY H. GARDNER

HOW A PIECE-WORK RATE WAS SMASHED

One of the methods of concave turning described in the article entitled "Machining Convex and Concave Surfaces" by Albert A. Dowd, which appeared in the January, 1914 number of MACHINERY, reminded me of an incident that occurred some six years ago in a certain manufacturing plant. This plant makes a great many cast-iron disks 8 or 10 inches in diameter, which are hollowed out "saucer fashion" on one side. The time-honored method of handling this work was to rough out the concave surface and then hand-tool it to fit a templet. One day a new man was hired and put on this job. He was anxious to speed up as much as possible, being paid by the piece; and after giving the matter a little thought, he sharpened the ends of a piece of drill rod of a length equal to the radius of the concave surface, and inserted the points in center punch marks in the cross-slide and tailstock. He then started the cross feed, keeping the carriage pressed against this radius rod, and proceeded to amass wealth.

In the afternoon caution somewhat over-balanced acquisitiveness, and he worked at less than his maximum rate; but when the whistle blew at closing time, he had finished six times as many pieces as his predecessor had ever turned out in a day. A little reckoning brought him to the happy conclusion that he had about $18 coming to him as the result of a day's work. He now virtuously resolved to do his utmost the next day, and being a dexterous youth, he saw from $20 to $24 almost within his grasp. But this, alas, is a world of disappointments; and before he could begin the day's work that was to add materially to his "bank roll," he received the disheartening tidings that the rate had been cut to one-eighth of its former enticing magnitude, and he had to hustle like a squirrel in a wheel to make $3 a day. Now this primitive method of working with a hand tool and templet was not used in "Lonelyville" but within three miles of MACHINERY'S office in New York City.

New London, N. H. GUY H. GARDNER

HIGH-SPEED STEEL JIG BUSHINGS

The inquiry of C. R. in the March number of MACHINERY, relative to the use of a high-speed steel jig bushing, calls attention to the prevalent misunderstanding regarding the degree of hardness of heat-treated high-speed steel as compared with heat-treated carbon tool steel. It is generally admitted by those who have tested the relative hardness of the two steels, that carbon steel can be heat-treated to give a considerably harder surface than any heat-treatment will give to high-speed steels. Carbon steel would, therefore, appear to be the better material to use in all places where wearing hardness is desired. The reason that high-speed steel is so desirable for cutting tools is that it retains its hardness under a service that develops considerable heat. A cutting tool of high-speed steel used in a lathe, for example, may be run continuously under a service which may generate sufficient heat to raise the temperature of the tool to a dull red heat. In other words, the cutting tool retains its hardness for effective cutting purposes even at a dull red. A carbon steel tool would, under these conditions, lose its hardness at once.

To recapitulate, high-speed steel, while relatively softer, retains its hardness under temperatures that are considerably in excess of those allowable for carbon steel. If this is clearly understood, it will do away with misunderstanding regarding its use. Tests with the Shore scleroscope as well as wearing tests made with cutting tools bear out the statement that high-speed steel is less hard after heat-treatment than is carbon steel. In resharpening carbon steel cutting tools great care had to be taken to prevent heating the cutting edge sufficiently to blue it. This led to the use of water grinding machines for resharpening cutting tools. With the advent of high-speed steel cutting tools, wet grinding was at first considered necessary. Repeated experiments have shown, however, that it is not necessary for the life of the tool, and that it is in most cases positively injurious to water-cool the tool when resharpening it. As C. R. desires hardness in his jig bushings for the sake of wearing qualities, and as the bushings are, while in use, relatively cool, carbon steel is the best for his purpose. CASE

As regards the question of the practicability of using high-speed steel for jig bushings there can be no possible advantage in its use for this purpose, unless there is an unusual heat developed by friction. The cost of high-speed steel is prohibitive and its resistance to wear is no greater than that of hardened high-carbon steel. The principal advantage in the use of high-speed steel for any purpose is that it will not lose its hardness at a low red heat—hence its value in the cutting of metal at high peripheral speeds.

To illustrate the above assertions regarding the wearing qualities of high-speed steel, the writer's experience along this line may be of some value to readers of MACHINERY. In the drilling of holes in hard carbon, we found that high-speed steel did not wear as long as glass-hard high-carbon drills when operated at low speeds, but when operated at high speeds with heavy feeds, the carbon steel drill points became blued very rapidly, losing their hardness, and consequently were short-lived. The high-speed drills operated in like manner would wear about five times as long, although the points become blue the same as on the carbon steel drills.

Cleveland, Ohio J. E. WASHBURN

SELECTING DIAMONDS

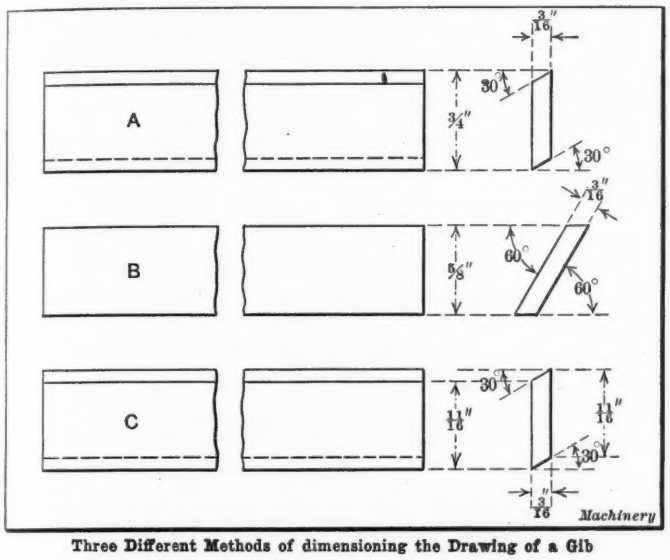
In reply to J. Towler's query in the January number of MACHINERY concerning the selection of diamonds, I would say that he is not alone in his experience of having apparently good stones crumble to dust almost immediately after they are put in use. Diamonds are a product of nature and their composition and temper were thus placed beyond human control. No dealer is justified in guaranteeing them. From the time they leave the hands of the diamond syndicate at the mines, and in passing from the cutter to the importer, and from the importer to the dealer, each man buys without a guarantee. Naturally the user is expected to do the same.

The firm with which the writer is connected is a large user of diamonds, but after fifteen years' experience in their selection we still have stones that "look good" go wrong. Permit me to suggest that those who are still using black diamonds investigate what are known as the Brazilian bortz or brown stones. These are sometimes called South African "premiers" and by other trade names. For truing up grinding wheels they are just as satisfactory as the black diamonds, and for $15 you can buy a brown bortz stone equal in size and weight to a black diamond costing $70 or $75. By way of conclusion, I would say that in selecting stones, the best plan is to avoid those which appear to have seams, as such stones are likely to crack along these seams,

while the smooth skinned stone is the most likely to prove satisfactory. Of course, the more points a stone has the better. GRINDING WHEEL MANUFACTURER

DIFFERENT METHODS OF DRAWING A GIB

The accompanying illustration shows three different methods of drawing a gib. In making a gib the first thing a milling machine or planer operator wants to know is what size of stock is needed to produce the piece without wasting time or material. It appears to the writer that the method illustrated at *A* enables anyone to see at a glance just the size of stock that is required. This illustration shows the thickness and the full width so that all that is necessary is to machine the gib to the required angle.



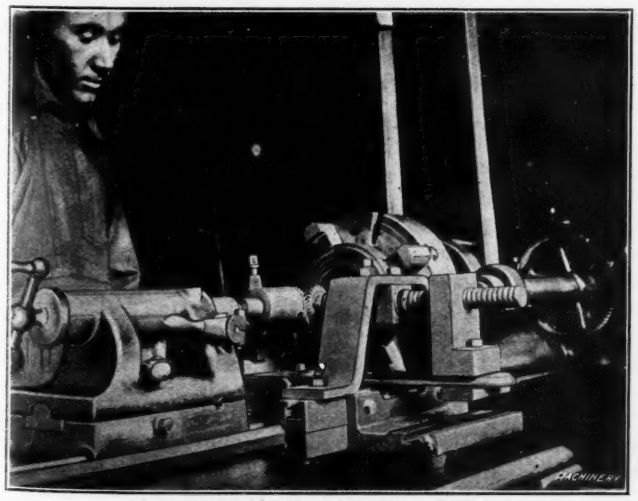
Three Different Methods of dimensioning the Drawing of a Gib

The illustration *B* shows the width of the gib after it has been machined to the proper angle; but how much stock is required to obtain this size? Illustration *C* shows the width of the gib from one edge to the other. In illustrations *B* and *C* the operator must either stop to figure out the size of stock that is required or else resort to guesswork. These drawings made by different draftsmen started an argument in regard to the best method of illustration. The writer claims that the method shown at *A* is the correct one, while another man advocates that shown at *B*, and still another claims that the one shown at *C* is the best. Who is right?

Pearl River, N. Y. W. BUTZ

CUTTING A SPIRAL ON A LODGE & SHIPLEY LATHE

A spiral is a very difficult thing to machine and a special lathe is generally required for this purpose. The accompanying illustration shows a Lodge & Shipley lathe cutting a 4-pitch spiral in a plate 6 inches in diameter, and it is the purpose of this article to describe the fixture used for this operation. After the blank was turned it was chucked as shown in the illustration. The feed is regulated by a screw with a pitch equal to the desired pitch of the spiral. This screw is driven by a miter gear which meshes with a gear fastened to a mandrel supported between centers. The screw works in a nut mounted at the rear end of the carriage, and the feed clutch on the apron may be disengaged to allow the carriage to be moved. This attachment is simple and may be constructed from odd pieces found around the shop. The gears are not necessarily miter gears, although these are preferable, as they simplify the calculation of the pitch of the screw.

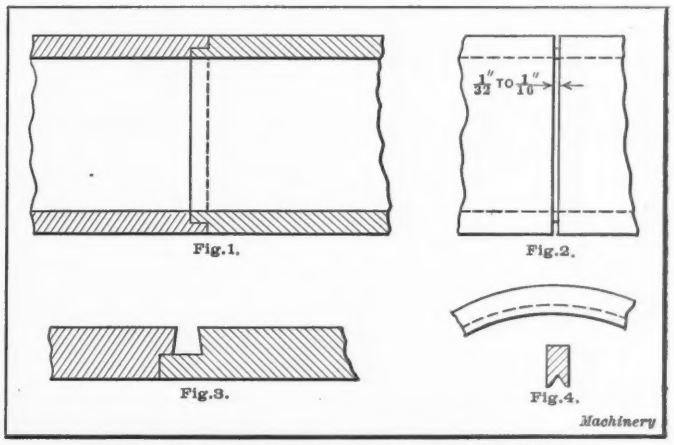


Lathe Fixture used for cutting a Spiral

Chattanooga, Tenn. RUSSELL K. ANNIS

BRONZE SHEATHING OF PROPELLER SHAFTS

The tail-shafts of ships, that is, the length of the propeller shafting which passes through the hull of the ship and on which the propeller is carried, is fitted with bronze sheaths or liners to prevent corrosion due to the action of the sea water. These liners are usually made in lengths of from five to six feet and are arranged so that when in position on the shaft a male and female joint come together as shown in Fig. 1. The method of securing them on the shaft is by shrinking. The liners are bored out smaller in diameter than the shaft, the usual allowance being 0.001 inch per inch of diameter of the shaft. Heat is applied either by means of a steam jet or by a gas or oil burner, until the liners have expanded sufficiently to allow them to be slipped over the shaft. Provided the shaft has been turned parallel and there has been little variation in the bore of the liner, a perfectly solid contact should result. The solidity can readily be tested by lightly tapping the liner with a hammer.



Joints between Sections of Propeller Shaft Sheathing

Great difficulty has been experienced in getting the liners to butt closely at the joints when cold. This, of course, is due to shrinkage. Local cooling with water at the joints has been tried, but fails to obtain the desired result and invariably we find that there is a space of 1/32 to 1/16 inch between the ends, as shown in Fig. 2. Such a condition is not acceptable in cases where rigid inspection obtains. To close this gap electric welding often is used. The joints are welded and the surplus metal is afterward removed in the lathe. With this method great difficulty was experienced in obtaining a homogeneous weld.

To overcome the annoyance and expense incurred by faulty welds, the following method has been devised. The liners are shrunk onto the shaft and the outside is finished as before. The space between the liners is enlarged until a groove ¼ inch wide and just deep enough to reach the outside of the male joint is obtained between each pair of liners. The sides of the grooves are then cut away slightly to form a dovetail. (See Fig. 3.) Into these grooves are driven segments of material having a cross-section similar to that shown in Fig. 4, until the circle has almost been completed. In fitting the last segment a space must be left around the circumference to allow for the expansion of the metal when all the segments are forced into the groove. This amount, of course, depends on the circumference of the groove.

To fasten the segments securely into the groove, the tail-shaft is revolved in a lathe and a knurling tool is pressed against the outside of the segments until they are completely flattened. A light cut is then taken with a finishing tool, to remove all surplus metal. The material used for the segments should be a soft combination brass such as is used for calking pieces in turbine work.

Sparrow's Point, Md. JOHN GRAHAM

WORK SPEEDS IN GRINDING

I hope your editorial in the December number entitled "A Question for the Grinding Expert" will bring forth a friendly discussion among grinding machine makers and users. It would certainly redound to the benefit of all. Grinding is no longer the "hit or miss" machine shop practice it used to be, but is becoming one of the leading shop operations. Yet no one has a monopoly of the knowledge of it.

Unfortunately many of those who are in a position to write authoritatively and entertainingly on grinding practice have not yet been "moved by the spirit." Charles H. Norton of the Norton Grinding Co. and J. H. Hollinger of the Landis Tool Co. have both, in times past, contributed to MACHINERY'S columns. I hope they will both continue and that we shall hear from some of the others as well. J. Kenyon, of the Brown & Sharpe Mfg. Co.; H. T. Shearer, of the Landis Tool Co.; B. M. W. Hanson, of the Pratt & Whitney Co.; H. K. Spencer, of the Blanchard Machine Co., and Mr. Wight, of the Diamond Machine Co., all could contribute funds of information regarding grinding operations.

To return to the subject suggested by your editorial, the satisfactory working of any grinding wheel (I refer now to automatic grinding operations) depends upon the question of feeds and speeds. Of course, in manufacturing grinding operations where similar pieces are constantly being ground, the wheel maker can supply a suitable grain and grade of wheel to meet whatever conditions of speeds and feeds the user may have established. But, when a grinding machine is used for all sorts of work—the "run of the shop"— it is manifestly impossible to change the wheel for every new job, and here is the importance of knowing how to change the feeds and speeds to do the various jobs quickly and efficiently.

The larger the surface of contact between work and wheel, the softer should be the wheel. The effect of a soft wheel can often be obtained by reducing the wheel speed. Inversely, if a wheel is wearing too rapidly, increasing the wheel speed will overcome the difficulty. I question your statement that "comparatively soft wheels are conceded to be the most efficient for roughing." Consider two specific operations, *viz.*, roughing cams and roughing crankshafts. For the former, very satisfactory results are being obtained on Landis and Norton grinders with 24-O corundum wheels, some (The Maxwell Motor Co.) preferring even coarser and harder wheels, *viz.*, 16-P corundum. Many operators may be surprised to know that such coarse hard wheels can be used for any automatic grinding operations, but they can and with excellent results. For finishing the cams, 46-K or 46-L corundum wheels are used.

For crank grinding, there are a variety of preferences as to grade, but none of the grades used could be considered "comparatively soft." No. 24 combination N is a favorite wheel for crank grinding, and from this up to grade Q, the latter being used by one of the largest auto manufacturers in the country. In crank grinding the usual practice is to use a wheel just as thick as the width of the pin to be ground, and to feed heavily right in without traverse. The wheel is then dressed true with a diamond, and the same wheel used for finishing, the finish cut being a light one.

Again I question your statement that the work speed is reduced for finishing. As a general rule, I believe that increasing the work speed, with a very light cut and a slow traverse, will improve the finish. One mistaken impression exists in many minds that a fine wheel must be used for finishing. A good commercial finish can be obtained with a wheel as coarse as 36, if it is kept true. For surface grinding, wheels *finer* than 30 or 36 are rarely used.

The above grains and grades referred to are those of the American Emery Wheel Works.

Providence, R. I. JAMES O. SMITH

CHART OF EXPERIENCE AND WAGES

The accompanying illustration shows a chart that can be conveniently used by a man in applying for work. The horizontal base line of the chart is laid off in years, while the left-hand vertical lines are laid off to represent wages. In

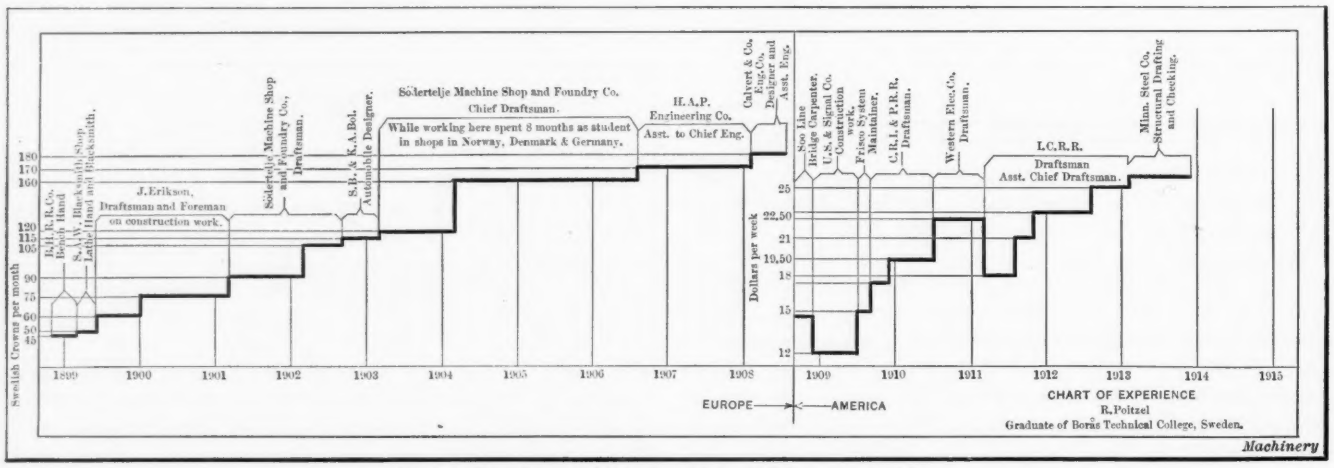


Chart of Experience and Wages used in applying for a Position

the left-hand chart, the writer's experience between the years 1899 and 1908 is shown, the wages being expressed in Swedish crowns per month. In 1908 the writer moved to America, and at this point of his career a new chart was started on which the wages are shown in dollars per week. Where such a chart is sent to a prospective employer, it shows at a glance just what experience the applicant has had and the wages he has received. Such a method could be extensively used to the mutual advantage of the employer and employe.

Duluth, Minn. R. POITZEL

LUBRICATING STICK

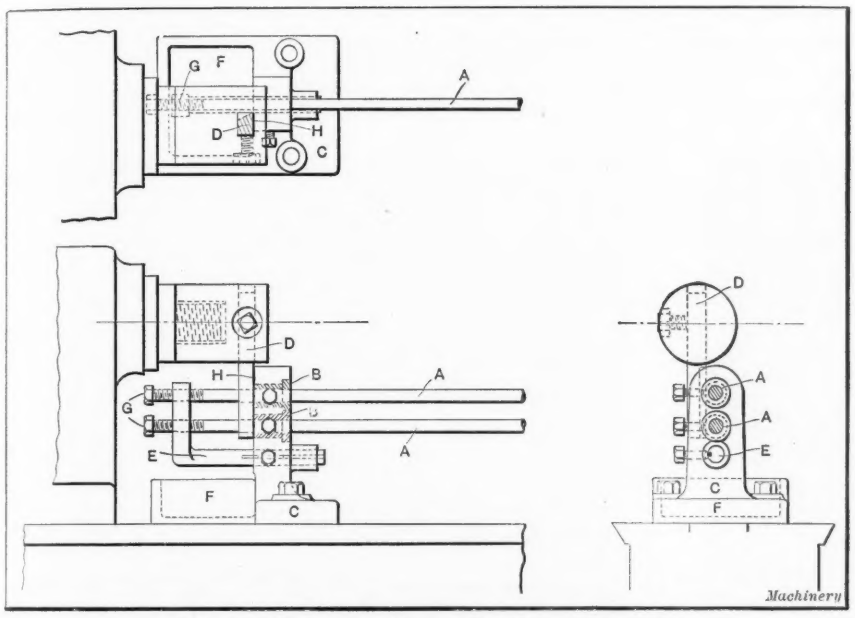
When sawing or drilling small copper, brass, or German-silver pieces, with small saws or drills, a fine lubricant is prepared as follows: (1) Make a solution of two parts of camphor in four parts of turpentine. (2) Melt together two parts of pure mutton tallow and one part of beeswax. To this melted mixture add about 5 per cent by volume of solution No. 1 and also a few drops of oil of lavender to offset any offensive odor. This mixture, while hot, is poured into paper tubes about one-half an inch in diameter and four inches long. These are made by winding typewriter paper around an arbor, gluing the layers together, and shellacking the outside when dry. When cold, these sticks should be quite hard, and may be handled without soiling the hands;

they are as convenient as a piece of beeswax and give better results. This stick has the end exposed by removing a narrow ring of the paper and is touched to the revolving cutter; the heat generated by cutting melts that which sticks to the cutter and lubricates thoroughly. In cases where cleanliness is a primary factor, this method is giving perfect satisfaction.

Southbridge, Mass. WARREN E. THOMPSON

LATHE ATTACHMENT FOR CUTTING OFF PINS

In setting up machines a great many pins for use in collars, dowel pins, etc., are required. It is the purpose of this article to describe an attachment for use on a lathe which provides for cutting off pins of various lengths from wire of different diameters. Referring to the illustration, it will be seen that the fixture provides for cutting off two pins at a time, the wires *A* from which the pins are cut passing through the bushings *B*, which are supported in a bracket *C*. This bracket is screwed to the bed of the lathe. The bushings are made interchangeable so that a number of sizes may be used for cutting pins from wire of different diameters. The cutter *D* is held in the tool-holder by means of a set-screw, the tool-holder being threaded to fit the lathe spindle. The bracket *E* acts as an adjustable stop, being fastened in any required position to suit the length of pins to be cut off by means of a set-screw. In operating the attachment, the wires are pushed through the bushings until they come in contact with the stops; the cutter then comes around and shears them off. Immediately after two pins have been cut off, the wires are pushed up against the stops in position for the next cut. As the pins are cut off they fall into the trough *F* which is an integral part of the bracket that supports the attachment.



Lathe Attachment for cutting off Two Pins simultaneously

It is possible that the cutter could be made longer and that a greater number of bushings could be used, in which case more pins could be cut off at each revolution of the cutter. The possibility of development along this line would depend upon the operator's ability to push more than two wires up to the stop before the cutter comes around for the next cut. By using different sized bushings and setting the stop-screws *G* in different positions, it is possible to cut off pins of different lengths and diameters at the same time. In operating this attachment, it is important to have the bracket *C* adjusted to such a position that the cutter slips over the surface *H* so as to give a good shearing action.

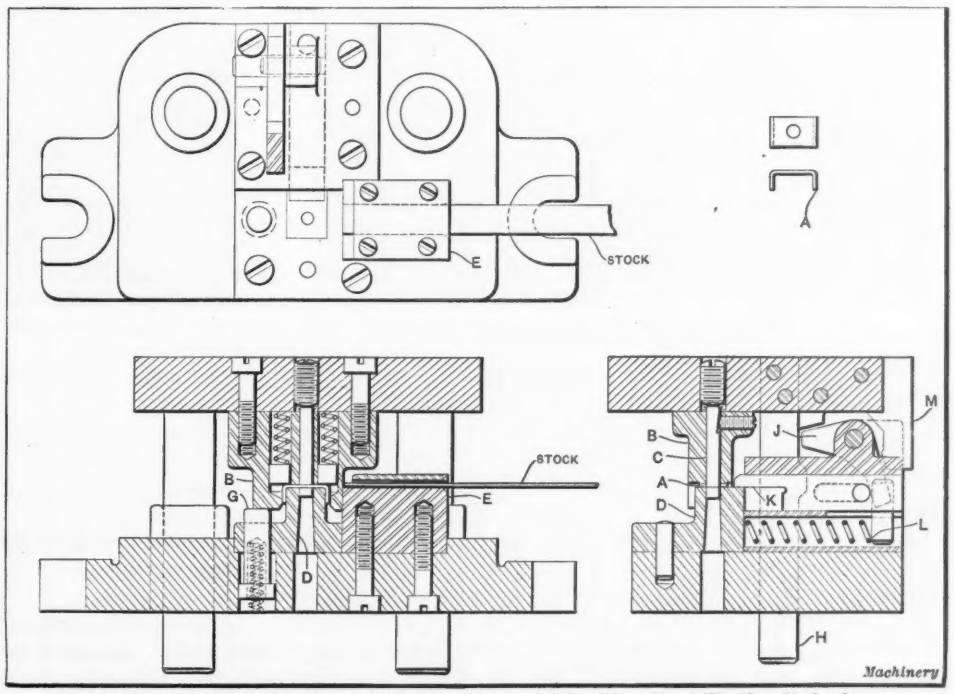
If it is desired to cut off long lengths of wire, the shearing cutter *D* could be fastened to a bar carried on centers and driven by a driving dog. In this case the bracket *C* would be placed on the bed of the lathe near the cutter, and a separate bracket with adjustable stops would be employed to control the length of the work. The second bracket would be fastened to the bed of the lathe. The attachment shown in the illustration is self-contained and when it is not in use it can be easily removed from the lathe.

W. R. O.

A NOVEL PUNCH AND DIE

The punch and die illustrated herewith is used for cutting off, forming and piercing pieces of the form shown in detail at *A*. These pieces are parts of an electrical switch and are made of 1/16-inch sheet brass. The interesting feature of the punch and die used in producing them is that an ejecting mechanism is provided to remove the finished pieces from the die, thus making it unnecessary for the operator to put his hands under the punch. After all, this is the surest method of preventing punch press accidents. The use of an automatic ejecting mechanism also permits the punch to run continuously instead of making it necessary to stop after each stroke to remove the work. In the illustration, *B* is the forming punch, *C* the piercing punch and *D* the die.

It will be seen that ribbon stock is used which is fed through a guide *E* until it comes up against the stop *G*. The punch is shown at the end of the down stroke. On the up stroke the hardened cam *H* engages the lever *J* which pushes the slide *K* forward and knocks the finished piece of work *A* off the die. The spring *L* returns the slide and the cam is so timed that it advances the slide before the stock can be fed forward for the next operation. The plate *M* is held in the punch-block to return the lever to the working position should it fail to return after the cam passes it on the down stroke. The work is cut off against the face of the



Combination Cutting-off Forming and Piercing Die provided with a Novel Ejecting Mechanism

guide *E*, and the arrangement of the strippers is evident from the illustration without requiring further description.

LAWRENCE FAY

SYSTEMATIC CALCULATIONS

The use of systematic methods of calculation is a subject which seems to have been neglected by the technical press. The writer's experience has been that the majority of draftsmen do not try to systematize their notes and computations. On the contrary, most of them use the loose and shiftless method of scratching upon a scrap of paper, marks and figures arranged in haphazard form, that are disconnected and incomplete. Such a habit is of no profit to either the draftsmen or their employers. In case a question arises in regard to the strength of a certain part of a machine, the draftsman would save himself and his employer much time and trouble if he had made his computations in such a manner as to make reference to them both intelligible and accurate.

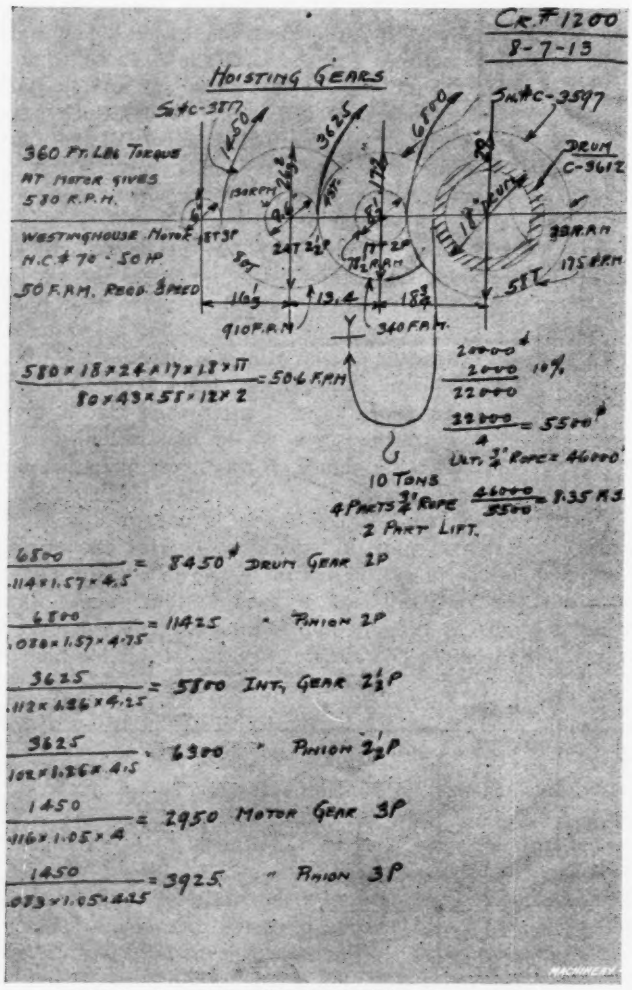


Fig. 1. Computation Sheet for Hoisting Gears—kept for Reference Purposes

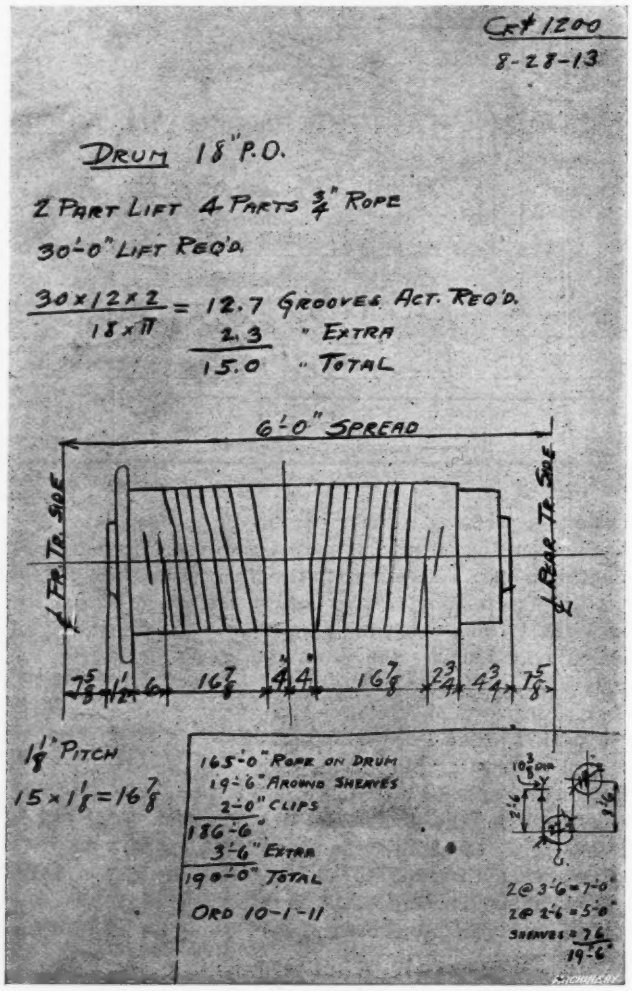


Fig. 2. Calculations for Hoisting Drum Grooves and Rope Length

To begin with, all the data regarding the calculations for a certain part of a machine should be put down. This is advisable because, while the designer knows exactly all the conditions of the case under consideration, a year or more afterward he will have forgotten them or, perchance, will have changed his position. If a mistake is made, instead of destroying the sheet of figures it is better to mark it void, because oftentimes computations which were thought to be wrong are found to be right. A "new" machine is seldom entirely new, but is generally an adaptation and modification of some other design. In this event carefully made and preserved notes and calculations of the old design are often useful. Then, too, proposals, estimates and bids which are generally required in a minimum length of time can be made up more quickly by the aid of such records.

Fig. 1 shows a computation sheet for hoisting gears. A careful perusal of this sheet will show that all the necessary and important data are given. The contract or machine number should appear on all such sheets, as well as the date of computing. It is often found necessary to use certain parts called for on different drawings, as for instance, in a train of gears it is desirable to use gears detailed on different drawings; in that case the number of each drawing should be noted upon the computation sheet with arrows clearly indicating just what gears are covered by that particular drawing. Such practice will prove of value in designing because, when the details are to be made, the designer knows just exactly what parts he intended to use. The gear centers are put down on this sheet and are found useful in laying out the general arrangement of the mechanism.

A method for figuring drum grooves and the length of rope required is shown in Fig. 2, together with an illustration of the drum giving the necessary dimensions for making a drawing. Many designers prefer to make their notes and calculations in a permanently bound blank book. The writer has found it convenient to use loose sheets held together with a spring paper clip, until the design for a machine is completed; the sheets are then riveted together for future reference.

The habit of making all notes, sketches and calculations clear, intelligent and complete, cannot be emphasized too strongly. The faithful and conscientious use of the aforementioned hints will, the writer believes, prove to be a great help to any draftsman and designer.

Toledo, Ohio CARL E. SCHIRMER

* * *

A successful engineer must build a man below him to take his place. He must do this with his eyes open to the fact that in time of grave financial crisis he may be discharged, so that the work can be carried on with a reduced pay roll, but this contingency is, after all, very remote. The 99-per-cent-certain result is that he, himself, is the logical candidate for advancement, because he will leave no aching void when he steps higher.—*J. M. Eaton in the Journal of the Worcester Polytechnic Institute.*

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

HOW TO COOL STEEL WITHOUT HARDENING IT

Very often a mechanic is working with a piece of tool steel and wants to cool it off without hardening it. Very simple you say. Lay the piece on the floor behind the forge and you will be able to handle it in fifteen minutes. When the piece is wanted for immediate use, however, it can be cooled quickly by plunging it into a pail of soapy water. When this practice is followed the steel will be soft enough to cut with a tool.

Middletown, N. Y. DONALD A. HAMPSON

FOR LAPPING SMALL HOLES

The most convenient method of handling emery or other cutting powder is in combination with ordinary non-fluid engine grease. Make a mixture by adding a small percentage of emery to the grease and stirring thoroughly. Care must be taken not to add enough powder to destroy the sticking properties of the grease. This may be applied to the lap by a stick and will not fly off as oil will. This mixture will also cut much faster than emery and oil.

Southbridge, Mass. WARREN E. THOMPSON

LUBRICATION OF SCREW MACHINE CUTTING TOOLS

After having had considerable trouble with oil gumming the movements of small automatic screw machines, all the oil was washed out of the machine and clean kerosene used in its place. For cutting screws from soft steel, German silver, and copper alloy wire, no better lubricant can be desired and the machines are never gummed or disagreeable to work on. The ordinary geared pumps handle kerosene satisfactorily if speeded a little higher than for heavier oil.

Southbridge, Mass. WARREN E. THOMPSON

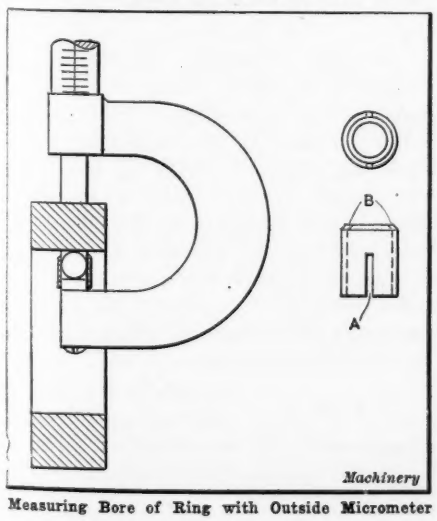
ENLARGING THE PILOT OF A COUNTERBORE

Experience has shown me that a very quick way of enlarging the pilot of a counterbore for counterboring an odd sized hole for which you do not wish to make a bushing is to cover the pilot with solder and then turn the solder down to the exact size of the hole. If care is taken to cover the pilot all over with solder and not to turn into the cutting edge of the counterbore when turning down to the required size, this method will be found very satisfactory for handling an emergency job.

Providence, R. I. JOHN W. HIRD

MEASURING THE BORE OF RINGS AND CYLINDERS

The following describes a rapid and accurate method of measuring the bore of rings or cylinders which have been machined on the outside. The first step is to measure the outside diameter of the work. The diameter of the bore that it is required to machine is then deducted from the measurement of the outside diameter, which leaves twice the thickness of the wall of the ring or cylinder. An outside micrometer is fitted with a steel ball ¼ inch in diameter, the ball being held in place by a short piece of ¼-inch tubing. This piece of tubing is split at *A* and spun over at *B*, thus forming a retainer which holds the ball in place on the anvil. After boring the hole to within 1/32 inch of the required size, the thickness of the wall is measured with the micrometer, as shown in the accompanying illustration. Then 0.250 inch is deducted from the micrometer reading to correct for the diameter of the ball. The thickness of the wall, as determined by calculation, is then subtracted from the corrected reading, which gives the amount of metal that still has to be removed. By this method holes can be bored or ground more accurately than when measurements are made with an inside micrometer. To obtain satisfactory results it is evident that the outside of the work must run perfectly true. To accomplish this, an accurate indicator may be used or the work may be held in a special spring chuck or on a magnetic chuck.



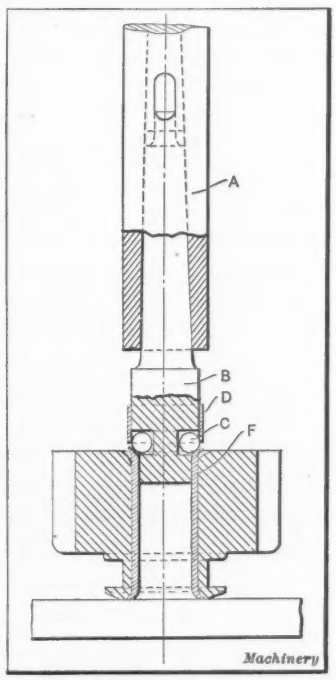
Measuring Bore of Ring with Outside Micrometer

New Britain, Conn. W. C. BETZ

A BEADING TOOL

The tool shown herewith was designed to rapidly bead over the ends of small bronze bushings such as are used extensively in motor car manufacture. In this way, the bushings are held securely in the bore of the sliding gears to which they are fitted. The beading was formerly done by hand but required too much time and the work was irregular. With the tool now used, the work is done rapidly as well as more uniformly.

This tool is used in a sensitive drilling machine. In the illustration, *A* represents the drill spindle and *B* the shank of the tool. The latter is made from steel and is hardened at its lower end where there is a groove carrying the balls *C*. These balls, which are kept in position by ring *D*, press against the upper rim of the bushing *F* while rotating and bead over the ends as the illustration indicates.



Ball Beading Tool for Gear Bushings

Turin, Italy. C. BOELLA

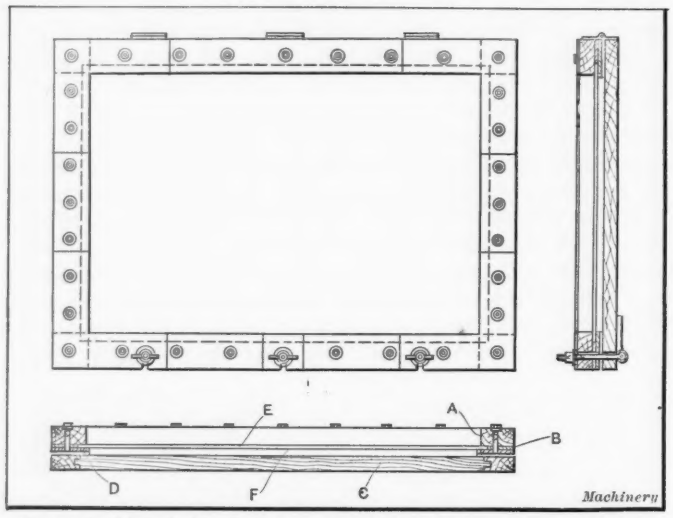
BLUEPRINTING FRAME

A frame for blueprinting by sunlight, in which a good contact between the glass and paper is secured is described by the following: The frame is made of hard wood and a sheet of glass is selected which is quite clear and free from bubbles. The glass must be of sufficient thickness to support the pressure and a sheet of ¼-inch plate glass will be found satisfactory for the purpose. The frame is mounted on a carriage that enables it to be placed in a convenient position for taking advantage of the best sunlight. It will be seen that this is not a "turn-over" frame but that the blueprint paper and tracing are inserted by lifting the cover in which the glass is set. The pressure is applied by means of three wing nuts carried by bolts which slip into slots in the cover.

The use of a frame of this kind is particularly convenient when it is desired to blot out any section of a tracing on the blueprint. As the tracing is always right side up and in plain view, it is unnecessary to turn the frame over in order to see whether the shield over the part to be blotted out is properly located, and ready to be exposed to the sunlight.

Although the first cost of a frame of this kind is a little more than that of a stock frame, the rapidity with which blueprinting can be done will soon make up for the difference.

Referring to the cross-sectional view, *A* represents the hardwood top strip, *B* the separating strip and *C* the base of the frame. Strips *D* are employed to hold the plate glass *E* in



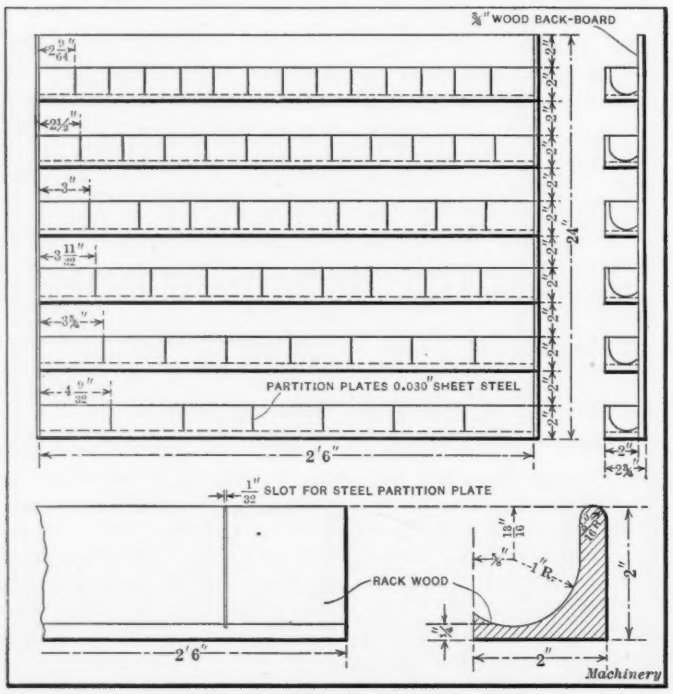
Frame for blueprinting that gives Good Contact between Paper and Glass

the frame. A sheet of felt *F* ½ inch in thickness is used to form a pad which takes up any inequalities in the pressure and insures having the blueprint and tracing held firmly against the glass at all points.

Philadelphia, Pa. C. W. CARRIGAN

RACK FOR SMALL DRILLS

The accompanying illustration shows what has proved to be a very handy as well as space-saving drill rack for small drills varying from No. 1 to No. 60. A rack of the same general construction could be used equally well for small taps. The tills are made from 2-inch square stock, planed in the carpenter shop to the shape shown in the sectional view. Care



Rack for Small Drills or Taps

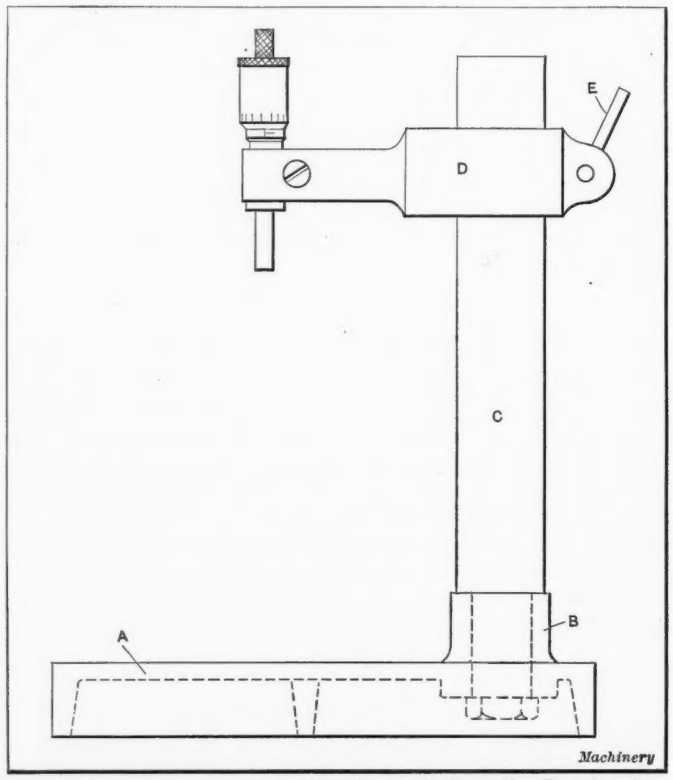
should be taken to form the tills so that there are no sharp corners into which the drills can roll.

The strips are cut 2 feet 6 inches long and are sawed for the steel partition plates, the spacing varying from 4 9/32 inches for No. 1 drills to 2 9/64 inches for No. 60 drills. The partition plates are made of sheet steel. These are assembled after the tills have been fastened to the back-board. Sheet metal end plates are used to close the outer ends and help support the tills. The cost of this rack is very small as compared with the drill cabinets often used. It should be placed on the wall within easy reach of the store-room window and will save the attendant many steps. There is ample space on the front of each till for marking the size of the drill and inserting a hook for the workman's check.

Pittsfield, Mass. C. E. PORTER

ADJUSTABLE MICROMETER HEIGHT GAGE

The adjustable micrometer height gage illustrated herewith was made to meet certain requirements in inspection work that were not fulfilled by standard gages; this special gage has also been found useful for a variety of purposes, other than in the inspection department, and will doubtless be of interest to readers of MACHINERY. It consists of two castings, a piece of turned steel and a micrometer head. The base casting *A* is of rather light section and is provided with a boss *B* in which the post *C* is carefully fitted. It will be seen that the post is turned to form a shoulder which abuts against the face of the boss *B*. The casting *D* carries a standard micrometer head in a hole bored for the purpose, while a hole is bored at its opposite end to fit over the post *C*. Both ends of the casting *D* are split in to the bored holes. The micrometer head is permanently secured by means of a screw which tightens the arm onto it. The position of the arm on the post may be adjusted by means of the binding screw *E*, which tightens it in any desired position.



Adjustable Micrometer Height Gage for use in Inspection Department

It is evident that a gage of this nature must be very accurately made to give satisfactory results. The upper face of the base casting *A* must be finished so that it is exactly perpendicular to the axis of the micrometer screw for all positions of the arm *D* on the post *C*. The micrometer head is set by means of an accurate standard. With the zero point determined in this way, pieces of work may be measured with the standard as the basis of comparison. The provision of the swinging arm, which can be adjusted to different heights, and the broad base of the gage has made it possible to measure many classes of work that cannot be handled with an ordinary micrometer or snap gage. This tool has found favor with all who have had occasion to use it.

Middletown, N. Y. DONALD A. HAMPSON

* * *

It is not so bad to build castles in the air as some people may think, provided, of course, that we go to work right away to put a solid foundation beneath them.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

COPIES OF FOREIGN PATENT SPECIFICATIONS

W. F. W.—To whom should I apply for copies of British and German patent specifications?

A.—Printed copies of British patents can be obtained from the Comptroller of Patents, 25 Southampton Bldg., London, England, and German patents, of Kaiserliches Patentamt, Gitschinerstrasse 97/103, Berlin, S. W. 61, Germany. Photographic copies of specifications and drawings of foreign patents can be obtained from the U. S. Patent Office, Washington, D. C. The cost of copies on paper 7 by 11½ inches, single page only, is 15 cents per print. Copies on paper 11½ by 14 inches, composing single or double pages, are 25 cents per print.

MAKING MICROMETER CALIPER SCREWS

H. G.—How are the screws of micrometer calipers cut? Are they afterwards lapped or not? Are they tested for pitch, and if so by what method?

A.—The practice of the different makers of micrometer calipers differs widely. One well-known maker cuts the screws on small special screw-cutting lathes in essentially the same manner as screws are chased on the ordinary engine lathe. Another well-known maker is said to cut micrometer screws in the automatic screw machine, using special chasing dies for the purpose. Another rolls the threads with thread rolling dies. All the makers test the screws for accuracy and some of them compensate for inaccuracies by inclining the datum line on the barrel to the axis of the barrel. The datum line is inclined to the right or left, depending on whether the screw is long or short in the lead. Contributions on the subject are invited from readers.

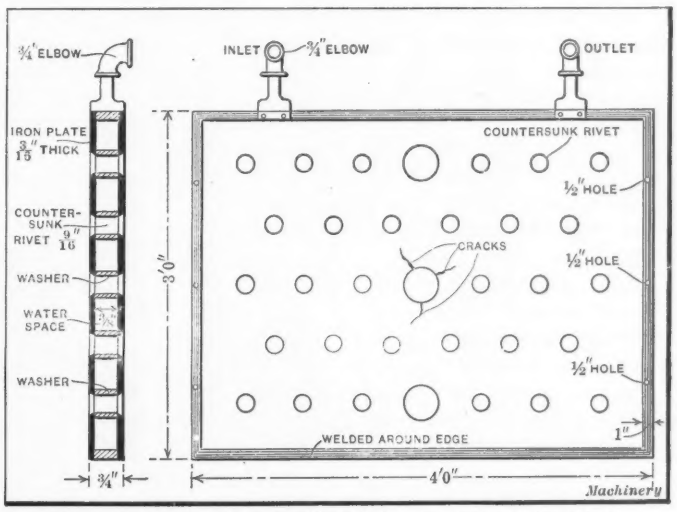
THE FOX LATHE

E. R. R.—I am running a Fox lathe. A friend asked me why it was called a Fox lathe, and I am unable to answer the question. Any information on the origin and history of this machine tool will be appreciated.

A.—The Fox lathe was first built by George H. Fox, who started in business with a partner as a machinist in Boston, Mass., in 1843. The lathe was developed some time between this date and 1859, when it was first advertised as the product of George H. Fox & Co., 45 Kingston St., Boston. The business was incorporated in 1864 as the American Machine & Tool Co., with Mr. Fox president, and this company has built it as a small side line ever since. Distinguishing features of the Fox lathe are a compound slide rest which in later years was usually surmounted by a tool turret and a screw chasing attachment, advertised by Fox as "Nason's patent screw chasing apparatus." This consists of a tool-holder clamped to a longitudinal round bar which is mounted in bearings so that it can both oscillate and slide endways. A half-nut, fixed to the bar, is brought into engagement with a short lead-screw when the operator pulls the chasing tool against the work. To change the pitch of the screw chased, it is necessary to change the lead-screw. Some improved forms of the Fox lathe have several lead-screws mounted on a revolving frame so that any one can be brought into use by turning a handle. The Fox lathe was also built many years ago by the Exeter Machine Works, Exeter, N. H. It is and always was primarily a brass-working lathe, and is widely used in the manufacture of brass valves, gas fixtures, plumbing supplies and other brass goods.

TO PREVENT RIVETS LEAKING IN STEAM PLATES

A. E. D.—We are using the oxy-acetylene welding process for welding rivets in steam plates of the form shown in the accompanying illustration with poor results and would like suggestions for overcoming the troubles. The steam plates are made of two iron plates three feet wide, four feet long laid on each side of a welded rectangular frame and are held together by rivet stays. The over-all thickness of the assembled plate is ¾ inch. The plates are 3/16 inch thick and ⅜ inch space is provided between them for steam and water. The rivets are 9/16 inch diameter and are spaced at intervals of about six inches each way; washers are provided between the plates to support them when riveting. These plates are used in the manufacture of underwear, about twenty of them being piled up on a press with the goods between them. A pressure of about sixty tons is applied in a hydraulic press, and, through pipe connections provided, steam is turned on for a certain time and then shut off and cold water is circulated through the plates. The result is that the expansion and contraction stresses are very severe and the rivets soon begin to leak. We have used the oxy-acetylene apparatus for welding the rivets to the plates but the plates crack around the heads. It then becomes necessary to put in



Steam Plate for treating Textile Fabrics that leaks at the Rivets

larger rivets, some of them now being as large as two inches diameter, but still the plates crack around the holes. They seem to crack worse since we started riveting them than before.

A.—The expansion and contraction stresses are very severe as you say, and unless the design of the plate is changed so as to reduce the severity of these stresses, cracking of the plates and leakage around the rivets will be unavoidable. We advise making the steam plates of uniform thickness throughout, as far as possible. The rivets should be discarded in favor of hollow screwed ferrules of the same wall thickness as the plates. These ferrules may be applied the same as staybolts, being threaded on the outside and screwed through tapped holes in the plates. When they are in place they should be cut off smoothly with the face of the plates and then they may be welded with the oxy-acetylene process. In this way you will obtain a steam plate which will expand and contract without setting up as severe stresses as when thick, solid rivets are employed. Suggestions from readers are invited.

* * *

NEW ELECTRIC GENERATOR SET!

A French inventor has produced a very practical (?) device for taking the requisite exercise in the home and incidentally producing the electric energy required for lighting a small house. He has combined a so-called "exerciser" made in the form of a bicycle (without wheels) with a dynamo and storage battery so that after taking the required exercise in the morning or evening, as the case may be, enough electric energy is stored up for several lamps for domestic lighting. It is pointed out that an important factor in favor of this device is the fact that generating the electric current gives stimulus to the use of the machine, and is intended to prevent neglect of the daily exercise, which becomes a necessity, or darkness prevails. The machine is designed to provide energy for a number of lamps after an hour's pedaling. When there are several members of the family the number of lamps may be increased indefinitely!

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GLEASON SPIRAL TYPE BEVEL GEAR GENERATOR

The machine which forms the subject of this article has been designed and built by the Gleason Works, Rochester, N. Y., for the purpose of cutting spiral bevel gears and pinions. This machine is of the generating type and is fully automatic. Fig. 1 shows the first of this type to be built, which is now in operation at the Gleason Works. Perhaps the easiest way to gain a clear idea of this machine is by comparison with the bevel gear generating machine built by the same firm for cutting straight tooth gears. The only essential difference in principle is that the new machine passes the tool through the blank in a curved path instead of in a straight path going to the cone center. The method of forming the tooth profile is the same in both cases, being the well known generating principle in which a tool representing the tooth of a crown gear is made to roll with the gear blank without slipping, cutting at the same time so as to roll out the tooth profile. The method of applying this principle in the new machine has been changed, as well as numerous details of design, some of which will be noted later. The curved tooth is obtained by building the cutter in the form of a face mill, as shown in Figs. 3 and 5, the curve being the arc of a circle whose diameter is the diameter of the mill. Fig. 3 shows the cutter as it is now being made, and Fig. 5 shows the original cutter.

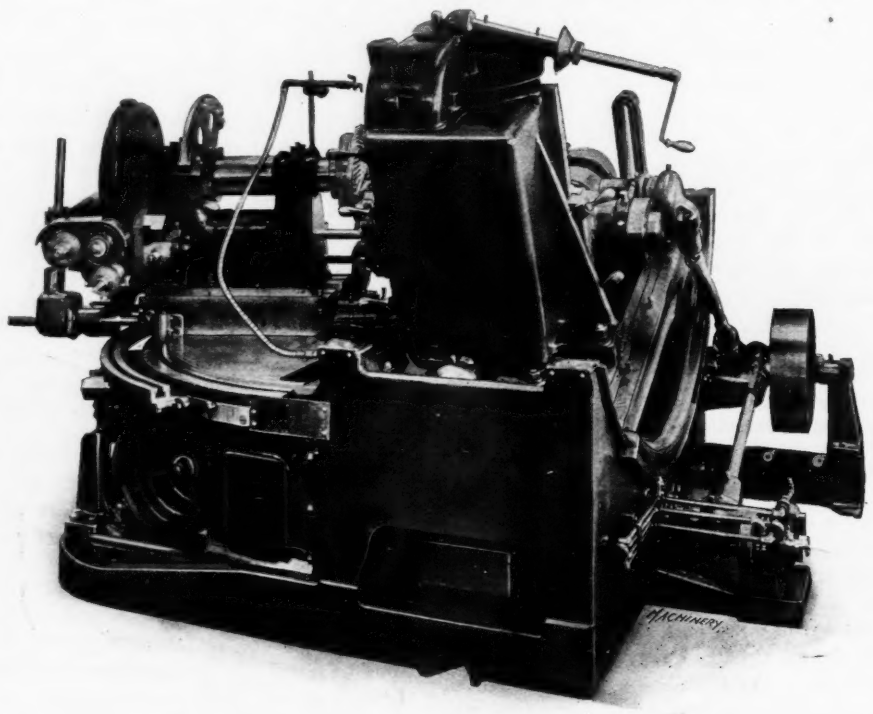


Fig. 1. Gleason Generator for machining the Spiral Type of Bevel Gears

The average diameter of the cutter is 12 inches, and there are twenty blades, ten cutting on the outside and ten cutting on the inside, the alternate blades having shear angles in opposite directions. The cutting side of each blade is ground to the pressure angle, and the other side is given a clearance. The cutting sides and the points of the blades are finished with a grinding attachment on a relieving lathe, so that in order to sharpen them it is only necessary to grind back on the face, and the cutting edge has the correct angle all the way back, the same as on a rotary cutter.

The wedge behind each blade is used in making the necessary adjustment after sharpening. All the cutting edges on each side of the cutter must work on exactly the same radius from the center of the cutter within a fraction of a thousandth of an inch. Otherwise the profile of a gear or pinion tooth would be a series of decided flats. It is practically impossible to remove the cutter from the spindle, mount it on a grinder and sharpen the blades, and then remount it on the cutter spindle and have the blades run true. With the wedge adjustment the cutter can be sharpened on a grinder, paying only a reasonable amount of attention to having the blades true; then, when the cutter is replaced on the spindle, the blades can be trued up by means of the wedges, one blade being set to a gage to maintain the proper diameter, and the rest of the blades being set to exactly the same reading on an indicator. This method has proved to be very successful. This adjustment was not provided in the first cutter, and is not shown in Fig. 5. The cutter head fits the spindle on a taper, and is held with four cap-screws. The same cutter is used for cutting both sides of a tooth, and for both the pinion and gear. It is necessary to remove it only for sharpening, and this is not often, on account of the large number of blades in action.

The shaft shown squared for a crank in Fig. 5 is a worm-shaft. The worm-wheel with which it meshes (seen in Fig. 2) is internally threaded, and adjusts the cutter spindle lengthwise, so that the plane of the points of the cutter blades contains the cone center of the gear or pinion to be cut. The cutter is supported by a column which stands on a large cradle; and it is through this cradle that the generating motion is applied to the cutter. The cutter and work are rolled together by means of a geared drive, instead of the crown gear and segment used in the straight tooth generators. A reversing mechanism (not shown) drives this generating roll, and it is applied to the cradle by a worm and worm-wheel segment, shown under the center of the cradle in Fig. 5. The same reversing drive is carried up through the center of the machine by means of a sleeve (Fig. 2), and back along the side of the head to a worm under the rear head bearing, which meshes with a worm-wheel segment fastened to the inside of a fan-tail hanging down from the spindle-carrying sleeve. The connection between this sleeve and the work-carrying spindle is through the index mechanism on the outside of the fan-tail, which is the same as the mechanism used in earlier designs, making the machine fully automatic.

The reversing mechanism has a fixed number of turns in each direction, and the amount of roll of the cutter-carrying cradle is controlled by a set of change gears, giving a small roll of the cradle for a pinion tooth and a large roll for a gear tooth. The relative roll between the cutter and the work is governed by a set of compound change gears on the drive going to the work-head. This ratio depends on the pitch angle of the gear or pinion that is being cut, according to the formula:

$$\frac{\text{Angle of roll of cradle}}{\text{Angle of roll of gear}} = \text{sine pitch angle of gear.}$$

A graduation in half degrees on the side of the cradle and a graduated plate with a vernier attachment on the work sleeve afford a means of testing this roll as a check. For example, in cutting the gear of a forty-nine- and thirteen-tooth combination, the pitch angle of the gear is 75 degrees 8 minutes. The compound gearing controlling the relative roll of the cutter and work must be such that taking into

consideration the constant of the fixed gears of the train, it will give:

$$\frac{\text{Angle of roll of cradle}}{\text{Angle of roll of work}} = \text{sine 75 degrees 8 minutes} = 0.96653.$$

To check this on the machine, assume any angle of roll of the cradle—say 30 degrees. Then the work must roll:

$$\frac{30}{0.96653} = 31.038 \text{ degrees.}$$

By rolling the cradle through the 30 degrees and reading the roll of the work on the vernier, this result can be checked within a minute, which is quite accurate enough for producing the correct tooth profile. When the machine was built, a differential mechanism was used on the reversing drive in addition to the compound gears in order to get the relative roll of work and cutter exactly. This was found in actual use to be an unnecessary refinement and has been discarded, a single set of compound gears giving the correct roll within a minute. The reversing mechanism is timed with the feed cam. The cut takes place during the up-roll of the cutter and work. During the down-roll, the work is swung away from the cutter by the feed cam, is indexed, and returned to the cutting position. The position of the cutter with relation to the cone center of the machine can be adjusted both vertically and horizontally. The vertical adjustment is obtained by raising or lowering the cutter spindle saddle on the ways of the vertical column by means of the lifting screw shown in Fig. 2. A horizontal screw adjusts the whole vertical column transversely on the top of the cradle. For each adjustment, a scale is provided for even inches, and a graduated dial for thousandths. One side of a tooth is cut at a time and in changing from one side to the other, it is necessary to give the cutter a slight adjustment, and set the blank over to a position that gives the correct tooth thickness. In changing from a gear to a pinion it is necessary to adjust the cutter vertically so that its center is above the cone center of the machine instead of below it. This is done to give the opposite hand of spiral on the pinion from that on the gear. The same horizontal setting answers for both sides of the gear and pinion teeth so that only the vertical setting needs to be changed when a job is once started. This machine has been built primarily for finish cutting, but by changing the feed cam and throwing out the generating roll, gears can also be stocked out. The stocking cutter is the same as the

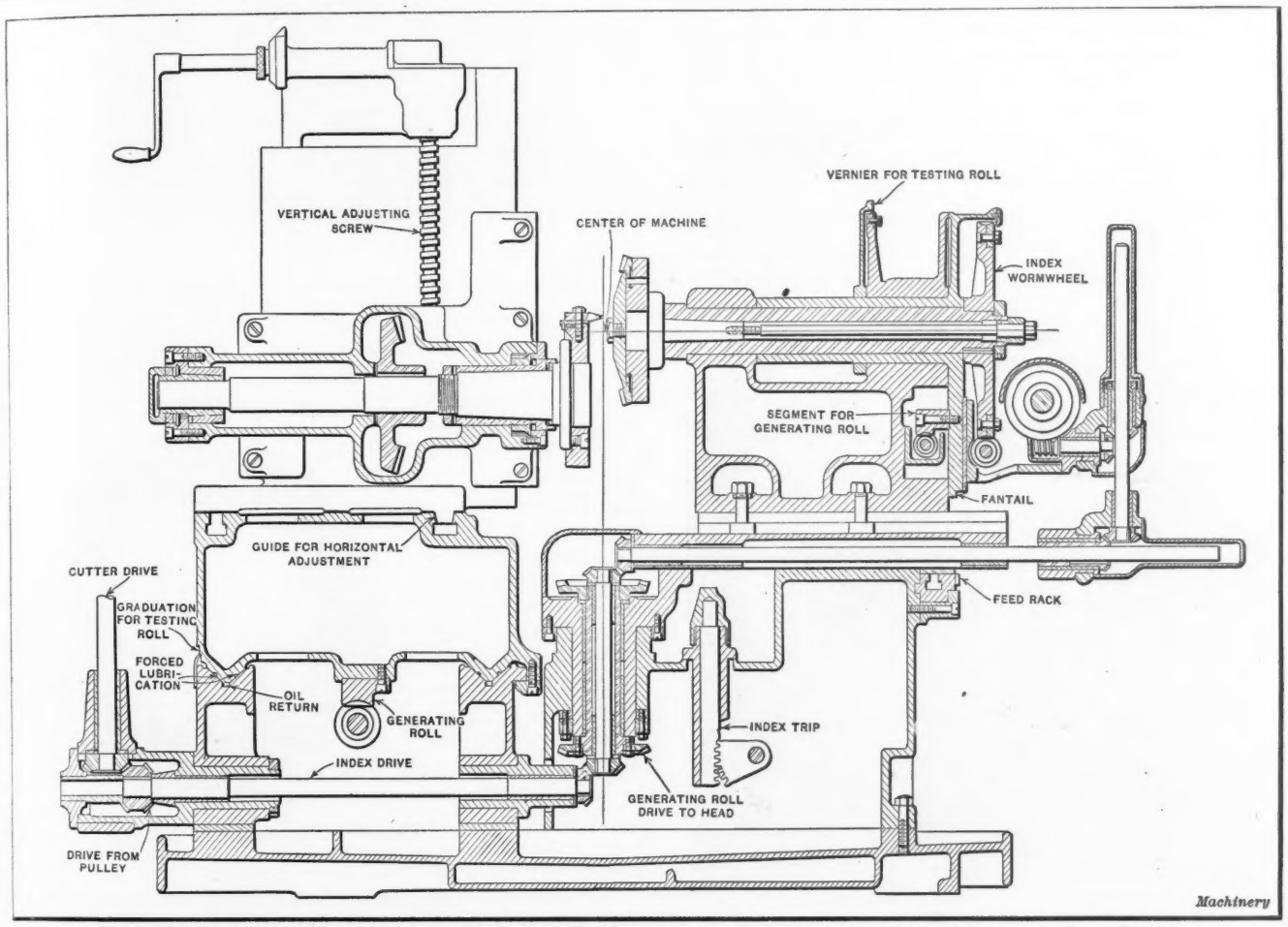


Fig. 2. Vertical Section through the Center Line of the Machine with the Work Head swung around to an Angle of 90 Degrees

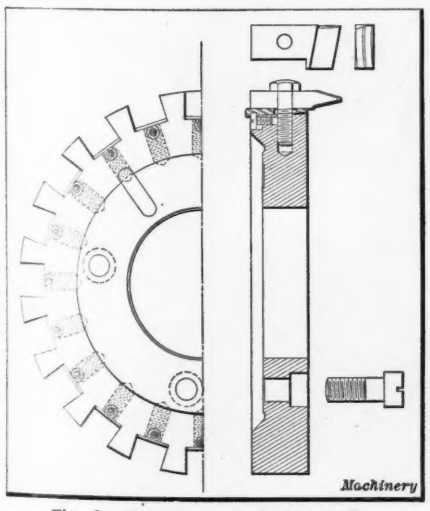


Fig. 3. Elevation and Sectional Views showing Construction of the Cutter

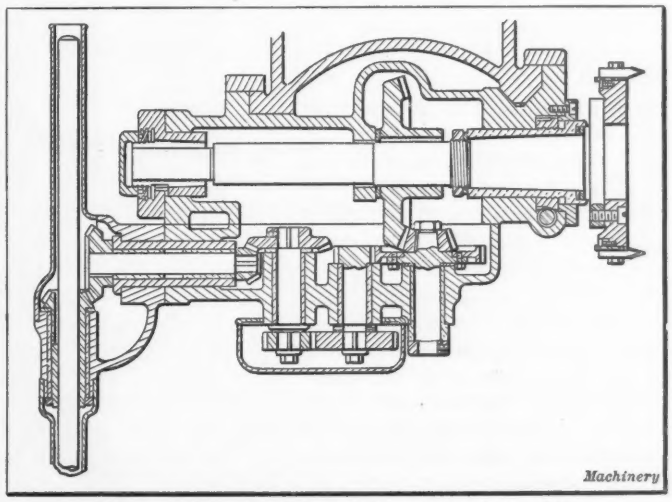


Fig. 4. Horizontal Sectional View of the Cutter-slide

finishing cutter except that there is no wedge adjustment for the blades, and the blades are ground with top rake. The stocking out is being done on a milling machine at the present time at the Gleason Works.

Fig. 1 shows the machine as it now appears. As this is the first machine built, there are several features which will be changed in the next machines. The new design of the cutter has already been described. Among other changes the universal joints in the cutter drive will be done away with, and the position of the oil pumps and piping will be changed.

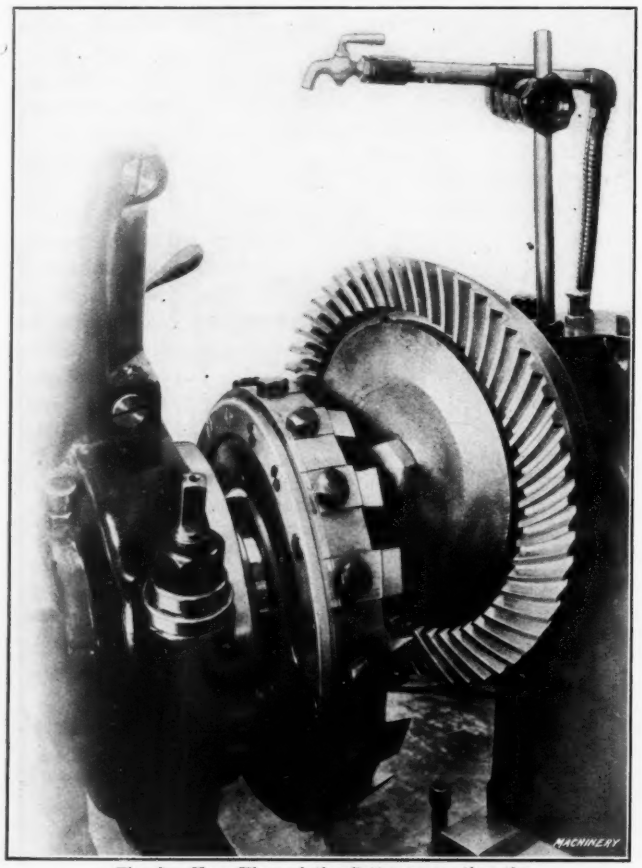


Fig. 5. Close View of the Cutter generating the Teeth in a Gear

The cutting time of spiral type gears compares very favorably with the time for cutting straight tooth gears. After stocking out a spiral gear it is necessary to cut each side of the teeth once, making two cuts around in generating. In straight tooth gears of high grade, it is usually necessary to make two generating cuts after the stocking out. Some gears and pinions at the Gleason Works have been cut with spiral teeth in the same time per set as the straight tooth gears. The average time for the spirals, however, would be a little longer than for straight tooth gears—from one to one and a quarter times as long.

Fig. 6 shows a few of the spiral bevel gears and pinions that have been cut at the Gleason Works, and Fig. 7 shows a single spiral bevel gear and pinion in mesh. Gears of a wide variety of combinations and pitches have been cut and have been subjected to severe tests by a number of automobile and axle manufacturers. In all cases the results have been very satisfactory. Trials of gear testing machines show that the pinion is capable of a wide range of adjustment with relation to the cone center of the gear, and this feature is a great advantage. It has been suggested that there is more sliding between the tooth faces of these spiral bevel gears than in the case of straight tooth gears, but this does not appear to be the case. Considering any section of a spiral gear tooth taken normal to a cone line, and a corresponding section of the pinion tooth,

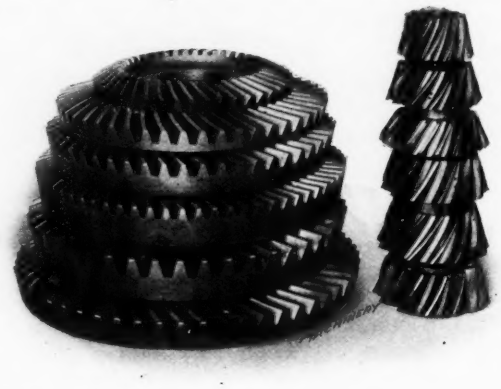


Fig. 6. Spiral Bevel Gears cut on the Gleason Generator

the shapes would be the same as corresponding sections for straight bevel teeth of the same pitch and combination, and the rolling action would be the same. Either the straight tooth or the spiral tooth may be considered as made up of an infinite number of such sections, and the fact that in the spiral tooth the sections are lined up with each other on a curve instead of on a straight line would not change the rolling contact. The angle of spiral used thus far has been such as to give a lead of about 1¼ to 1½ the circular pitch in the width of face, and this has shown very good results in quiet running.

Fig. 7. Spiral Bevel Gear and Pinion in Mesh

The same cutter is used for both sides of the tooth, and for both pinion and gear. The outside of the cutter cuts the concave side of the tooth, and the inside cuts the convex side. The gear and pinion tooth faces in contact are thus cut on slightly different diameters of the cutter, and this results in the bearing being heavy at the center of the tooth. The amount of this difference of curvature is very slight, however, and in the average automobile gear the bearing can just be seen to fade away at each end of the tooth.

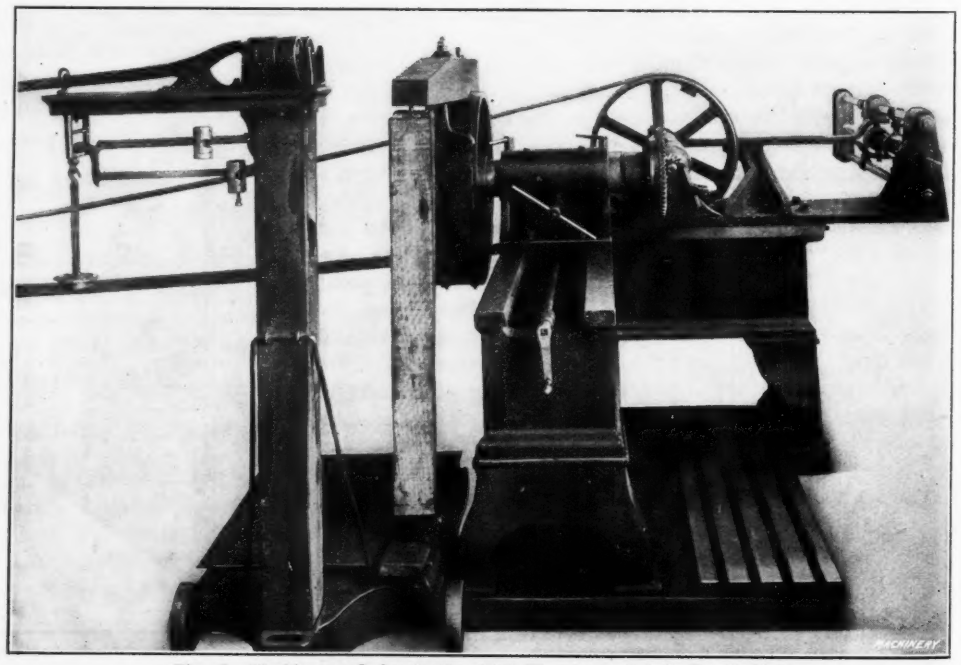


Fig. 8. Machine used for testing End Thrust of Spiral Bevel Pinions

One of the first questions that arose in connection with the use of these gears was as to the end thrust of the pinion caused by the spiral angle. The apparatus shown in Fig. 8 was used in tests made to determine the amount of this thrust. Power was applied to the pinion shaft, and the load transmitted was measured by a Prony brake on the gear shaft. The pinion shaft was free to float endwise, within certain limits, and within this range was held by a lever seen at the back on the right of the drive pulley. The other end of the lever was connected with a spring in compression (at the extreme right) so that any tendency of the pinion to thrust back brought the load on the spring. By means of a threaded handwheel the position of the spring could be adjusted endwise so as to bring the pinion back to the correct running position with each change of load on the gear. The amount of thrust could then be read by means of graduations on the spring-carrying bar, the spring having been calibrated before the tests were made.

Tests of the end thrusts were made with four pairs of bevel driving gears and pinions. The first test was made with the usual straight tooth type of bevel gear; the second and third tests were made with spiral bevel gears of different spiral angles; and the fourth test was conducted with skew bevel gears. All four pairs of gears used for these tests were cut on generating machines. For the first test the usual straight tooth gear generator was used; the gears for the second and third tests were cut on the Gleason spiral type bevel gear generator, the elements of the teeth being curved; and the gears for the fourth test were cut on a generating planer, so that the elements of the teeth are straight, but do not pass through the cone center, the tools being offset so as to pass above the center in cutting the gear and below the center in cutting the pinion. The direction of the spiral on the gears for tests No. 2 and No. 3, and of the skew for test No. 4 was the same—right-hand on the pinion. This results in a tendency to pull the pinion in toward the cone center in the forward drive, and to thrust it back against its bearings in the reverse. The straight tooth gears used for test No. 1 show a backward thrust, and the spiral and skew gears have this backward thrust combined with the pull or thrust due to the angle of the spiral or skew. The results presented in the table show the net values of these two forces—the pull due to the spiral minus the backward thrust of the straight tooth gears in the case of the forward drive; and the thrust of the spiral plus the backward thrust of straight tooth gears in the reverse drive. This accounts in a large measure for the results on the reverse being so much greater than on the forward drive.

In tests No. 2 and No. 3 the angle of the spiral is measured midway between the two ends of the tooth—this being the point at which the pressure is heaviest in this style of gear. In test No. 4 the angle of skew is measured at the large end of the tooth. If the angle of the spiral of the gears used in tests No. 2 and No. 3 were measured at the large end of the tooth, it would be greater than at the mid point, and the thrust would be less in proportion to the angle. Similarly, if the angle of skew of the gears used in test No. 4 were measured at the center of the tooth, it would be greater than at the large end, and the thrust would again be less in proportion to the angle. The method of measuring the angle, therefore, seems fair to both types of gear. The results given in the table show that the amount of end thrust or pull varies with the angle, and does not depend on whether the gears are of the spiral or skew type—the spiral type of pinion of greatest spiral angle showing the greatest thrust, the skew with a less angle showing less thrust, and the spiral

RESULTS OF TESTS OF THE END THRUST OF DIFFERENT TYPES OF PINIONS

Straight Bevel Gears

15 and 53 teeth; 0.7032 inch circular pitch; 1⅝ inch face width

Drive			Reverse		
Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100-pound Tooth Load	Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100-pound Tooth Load
163.9	9.86	6.01	163.9	9.86	6.00
328.0	19.75	6.02	328.0	19.75	6.02
493.0	34.70	7.04	493.0	29.60	6.00
659.0	47.33	7.18	659.0	47.33	7.19
815.0	62.50	7.67	815.0	65.80	8.08
986.0	77.60	7.86	986.0	87.46	8.86
1152.0	97.40	6.72	1152.0	96.76	8.38
1312.0	108.60	8.28	1312.0	111.76	8.50
1480.0	121.73	8.23	1480.0	126.83	8.56
1648.0	138.30	8.40	1648.0	141.46	8.60
		Average, 7.341			Average, 7.619

Spiral Type Bevel Gears

Spiral angle, 31 degrees 21 minutes; 15 and 53 teeth; 0.7032 inch circular pitch; 1⅝ inch face width

Drive			Reverse		
Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100-pound Tooth Load	Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100 pound Tooth Load
.....	.....	.....	163.8	118.6	72.2
286.0	—138.3	—48.3	329.0	237.0	72.0
451.0	—217.0	—48.1	492.0	358.3	72.8
615.0	—306.0	—49.8	658.0	477.3	72.4
782.0	—381.6	—48.9	816.0	608.6	74.6
944.0	—457.3	—48.4	989.0	740.0	74 8
1110.0	—559.6	—50.4	1150.0	858.0	74.7
1275.0	—641.0	—50.2	1315.0	979.6	74.5
1439.0	—730.0	—50.6	1482.0	1119.6	75.3
1609.0	—813.3	—50.6	1645.0	1231.0	74.9
		Average, —49.5			Average, 73.82

Spiral Type Bevel Gears

Spiral angle, 19 degrees 45 minutes; 14 and 53 teeth; 0.681 inch circular pitch; 1½ inch face width

Drive			Reverse		
Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100-pound Tooth Load	Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100-pound Tooth Load
.....	.....	.....	.....	.....	....
374.0	— 98.8	—26.40	366.0	148.1	41.6
558.0	—150.8	—27.00	554.0	242.0	43.7
732.0	—207.0	—28.30	740.0	336.0	45.4
929.0	—276.0	—29.70	858.0	390.0	45.4
1115.0	—325.5	—29.20	1045.0	474.0	45.3
1305.0	—384.5	—29.45	1228.0	563.0	45.9
1495.0	—440.0	—29.45	1416.0	642.0	45.4
1675.0	—493.0	—29.40	1602.0	746.0	46.5
1885.0	—555.3	—29.45	1810.0	830.0	45.8
		Average, —28.70			Average, 45.00

Skew Bevel Gears

Skew angle, 23 degrees 46 minutes; 18 and 57 teeth; 0.6803 inch circular pitch; 1¼ inch face width

Drive			Reverse		
Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100-pound Tooth Load	Tooth Load in Pounds	Average End Thrust on Pinion in Pounds	Thrust per 100-pound Tooth Load
131.7	— 39.5	—30.1	131.7	65.6	49.8
262.0	— 79.0	—30.1	262.0	138.0	52.7
390.5	—121.7	—31.15	390.5	194.0	49.6
521.0	—164.5	—31.55	521.0	266.5	51.2
649.0	—204.0	—31.45	649.0	332.2	51.1
778.0	—237.0	—30.50	778.0	394.5	50.7
909.0	—279.5	—30.65	909.0	461.0	50.7
1042.0	—312.5	—30.00	1042.0	533.0	51.1
1169.0	—352.5	—30.10	1169.0	592.0	50.6
1291.0	—385.0	—29.80	1291.0	652.0	50.4
		Average, —30.54			Average, 50.79

with the smallest angle showing the least thrust. The load has been given in pounds instead of in horsepower, since a given horsepower would put different loads on the teeth of pinions of different diameters. The load has been figured for the mid point of the tooth, *i. e.*, on the mean pitch radius of the pinion. The speed of the pinion in all runs reported was constant at about 260 R. P. M. A series of runs made at different speeds up to as high as 360 R. P. M. of the pinion showed the same thrust per 100 pounds of tooth load. Negative results indicate pull in toward the cone center; positive results indicate thrust away from the cone center. In each run the gear was loaded up to about 10 horsepower. Three independent sets of readings were taken in each case, and the results given are the averages of these sets of readings.

NOBLE & HUNT FOOT PRESS

Noble & Hunt, Newark, N. J., have recently developed a foot press of improved design which is shown in the accompanying illustration. This machine is intended for use in the manufacture of jewelry, metal novelties and other work of relatively small size. The features of the press are strength, extreme accuracy of the stroke and improved facilities for setting the die. It will be noticed that while the design follows the established lines of machines of this type, it is exceptionally heavy at the throat. The press is mounted on an iron stand and the slide has unusually long bearings which insure adequate support and reduce the possibility of deflection of the punch.

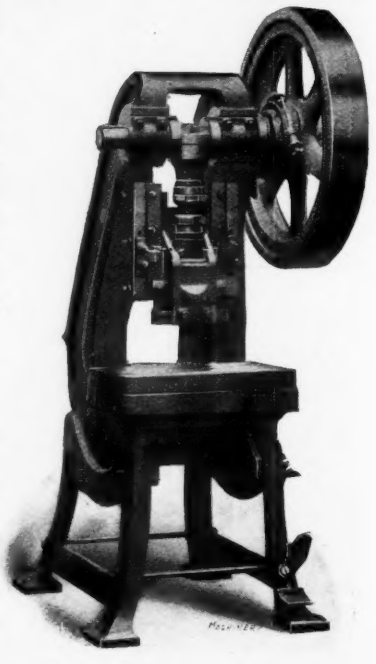
Ample leverage is provided. The motion from the end of the lever is transmitted to the ram by means of a link which

Noble & Hunt Foot Press with Improved Device for clamping the Die

is so designed that it obviates the danger of throwing the slide out of line while it is descending. This feature, in connection with the long slide bearings, increases the accuracy with which the machine operates. The usual stop or bumper is supplied at the back of the press to limit the backward stroke of the lever. The automatic clamping of the die plate is effected by means of the lever at the right-hand side of the machine. Trouble is often experienced in die setting because unequal tightening of the nuts causes the die to creep to one side, thereby throwing it out of line with the punch. With this press, the die plate is put in an approximate position and after the punch has located the die correctly on the die bed, the hand lever is thrown over, thus setting the clamps down firmly without requiring the use of a hand wrench. The lever for actuating the clamps works in conjunction with an eccentric motion. This clamping feature is one that will be readily appreciated by users of small dies. The press and stand have a total weight of 750 pounds.

WATERBURY FARREL INCLINABLE PRESSES

The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has recently brought out a line of inclinable open-back presses which are known as the standard Series E. These machines have an exceptionally large tool space and are of unusually heavy construction. They are adapted for a great variety of press work, the construction being such that various types of automatic feeding attachments can be readily applied. The housings are tied together at the back to increase the rigidity and the slide has bearing surfaces of ample proportions. The overhanging type of construction for the crankshaft and slide gives the maximum amount of tool space in all directions as well as permitting the attachment of the knock-out shown in the illustration.



Waterbury Farrel Series E Inclinable Open-back Presses

The crankshaft is made of high carbon machine steel, and runs in capped bearings. The Waterbury Farrel improved Johnson clutch is used, which has a particularly efficient friction. These machines can be built with back gears to meet the requirements of heavy work handled at a moderately slow speed. In addition to the floor type of machine illustrated, presses of this type are made in a small size for bench work. The machines are particularly adapted for use in the manufacture of tin boxes and similar classes of work.

WHEELOCK FLEXIBLE CUTTING LUBRICANT TUBE

Fig. 1 shows a flexible metallic tube for use in supplying the lubricant to the cutters of machine tools, which is a recent product of the Wheelock Mfg. Co., Wheelock, Vt. No

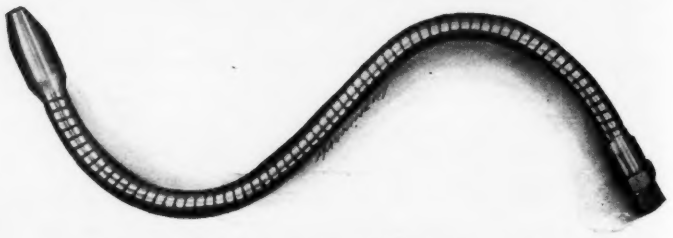


Fig. 1. Wheelock Flexible Cutting Lubricant Tube

packing of any kind is used in this tube; it consists of two steel wires which are wound together in such a way that a perfectly tight tube is produced. A cross-sectional view of the tube is shown in Fig. 2, from which the construction will be readily understood. The tube can be easily bent to any desired curve, and is sufficiently rigid to stay in the position to which it is bent. Owing to its flexibility, one end of the tube may be attached to the traveling carriage or other moving part of a machine. This feature is the chief advantage

of the Wheelock tubing over solid piping, which, if attached to such a moving part, must be provided with swinging joints or telescoping joints which are very apt to give trouble through leaking. In addition, such piping is more expensive and cumbersome.

The brass fittings used at either end of the Wheelock tubes are provided with standard pipe threads, and any

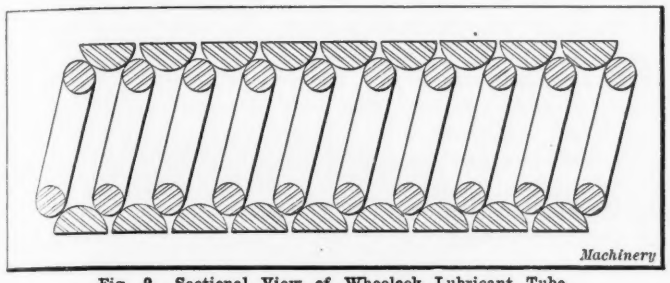


Fig. 2. Sectional View of Wheelock Lubricant Tube showing Construction

special form of fittings or nozzles may be provided. This tubing is made in three sizes which have bores ¼, ⅜ and ½ inch in diameter, and the tubing may be made of any desired length.

MOTOR DRIVE FOR SPRINGFIELD SHAPER

Motor drive applied to a 15-inch crank shaper built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, is illustrated in Fig. 1; and Fig. 2 shows the gear box which, in connection with the constant-speed motor

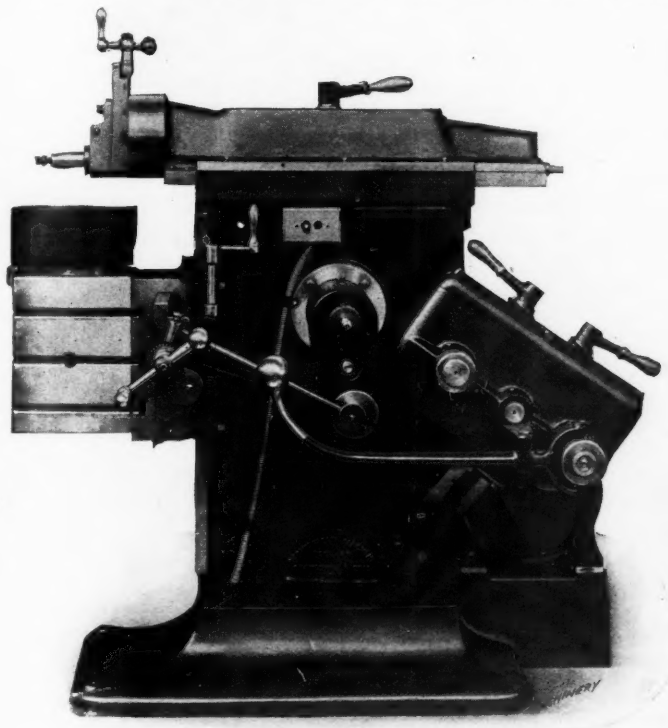


Fig. 1. Motor Drive applied to a Springfield Shaper

drive, provides four changes of speed. The changes of speed may be instantly obtained. The drive is connected by means of a friction controlled by a lever, and the operator can select the desired speed and engage the power without being required to make any adjustment of the motor. This motor-drive equipment has been put on the Springfield shaper to adapt it for manual training school service, where it is used to illustrate the individual motor application.

The rawhide pinion through which power is delivered to the friction gear is entirely encased and a box attached to the shaper contains the starting switch, fuses, etc. The current is controlled by a push button which is shown in Fig. 1, and it will be noticed that the motor is mounted directly on the machine base. Any type of motor may be employed. Referring to the view of the gear box shown in Fig. 2, it will be seen that sliding spur gears are used which are controlled by levers shown in Fig. 1. The arrangement is such that it is impossible to engage more than one speed at a time. Both the machine and motor drive are of rigid construction and constitute an excellent equipment for either demonstrating purposes or shop work. Aside from the feature

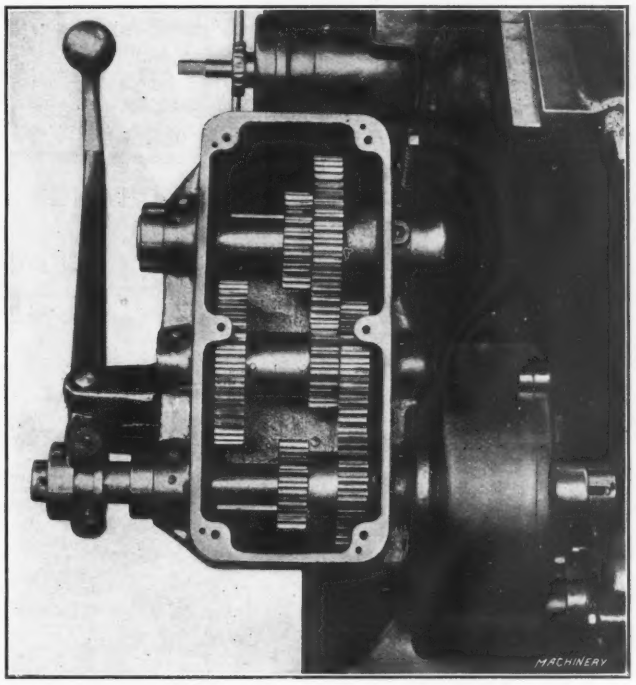
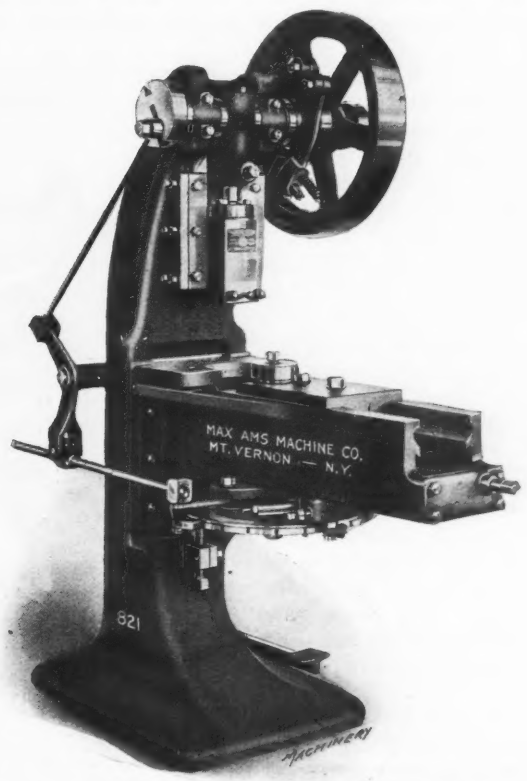


Fig. 2. Interior View of the Gear Box

of motor drive, the shaper is the regular 15-inch Springfield crank shaper which has been on the market for a number of years.

MAX AMS NOTCHING PRESS

The accompanying illustration shows a machine for notching armature disks from 4 to 30 inches in diameter, which is a recent product of the Max Ams Machine Co., Mount Vernon,



Max Ams Press for notching Armature Disks from 4 to 30 Inches in Diameter

N. Y. The design has been worked out along lines which adapt the machine for doing accurate work at a speed ranging from 250 to 325 revolutions per minute. A clutch is provided which grips the wheel centrally at several points. The

indexing is obtained by an index ring that is fed and locked positively, and so arranged that wear on the teeth of the index wheel is reduced to a minimum. Other features of the machine consist of the adjustment of both the slide and the die bed by means of screws, thus providing for variations in the height of the punches and dies. The adjustment for disks of different diameters is made by a screw conveniently located at the front of the machine. When notching disks which have no keyways, a clamping arm can be used to hold the work. Depressing the treadle starts the machine and it stops automatically as soon as the disk is finished.

SPRINGFIELD 24-INCH QUICK CHANGE GEAR LATHE

For a number of years the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, has been building "Ideal" rapid change gear lathes, but the change gear device has never been applied to machines of more than twenty inches swing. To meet the demand for a larger quick change gear lathe, this company has recently added the quick change gear device to its twenty-four-inch machine, the first lathe to be equipped in this way being shown in Figs. 1 and 2.

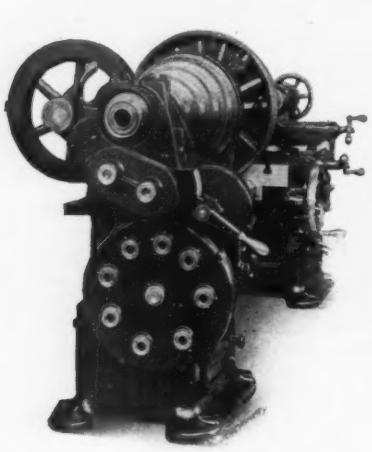


Fig. 1. End View of Springfield Lathe

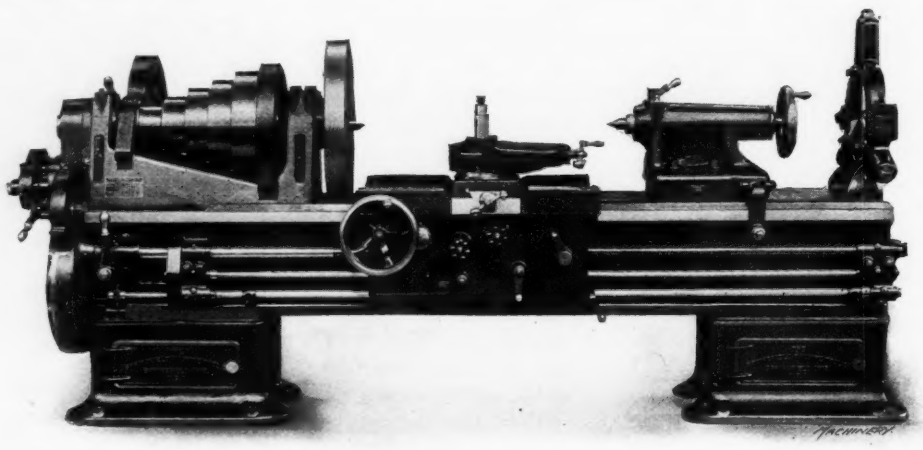


Fig. 2. Springfield 24-inch Quick Change Gear Lathe

The quick change gear device furnished on this lathe is of simple and efficient construction. Only seven gears are used when chasing right-hand threads and eight gears when chasing left-hand threads. The lead-screw is not splined. Feeds are transmitted to the apron by the regular feed-rod and the automatic stop operates in either direction. The reverse mechanism which is controlled at the apron operates both the lead-screw and feed-rod and is actuated by means of spur gears at the rear of the headstock. Particular care is taken in cutting the lead-screw and its accuracy is guaranteed.

The other features of the lathe may be briefly referred to as follows: It is equipped with a five-step cone pulley, single back gears, compound and steadyrests, large and small face-plates and a double friction countershaft with self-oiling bearings. The spindle is made of 60-point carbon steel, and lumen bearing metal or phosphor-bronze is used for the journal linings. The spindle journals are adjustable and ring oiled, the thrust being taken on the rear housing by means of cast-iron and hardened steel collars. The apron is of the double plate type, providing support at both the front and back of all shafts. Longitudinal and cross feeds are engaged by means of frictions and no tumbler gears are used. The tailstock is recessed and can be set over for turning a taper. Aside from the application of the quick change gear mechanism, the lathe is not new, so that a detailed description is unnecessary at this time.

RAHN-LARMON LATHE

The 16-inch engine lathe illustrated in Fig. 1 is being manufactured by the Rahn-Larmon Co., Cincinnati, Ohio. The design has been worked out with the view of meeting the requirements of modern manufacturing practice, being simple, accurate and providing ease of operation. The bed is of heavy construction and firmly braced for its entire length with box girders to provide for absorbing the vibration of the heaviest cuts. The headstock is bolted to the bed. The spindle is hollow; it is made of high carbon steel and ground perfectly cylindrical. The centers are No. 4 Morse taper hardened and ground to run accurately. The bearings are bushed with gun metal and provided with means of compensating for wear. The driving cone is of large diameter and designed to carry a wide belt; either single or double back gears, and a three, four or five step cone pulley may be used. The tailstock is of the offset type, which allows the compound rest to be placed parallel with the bed; and the tailstock may be set over for turning tapers.

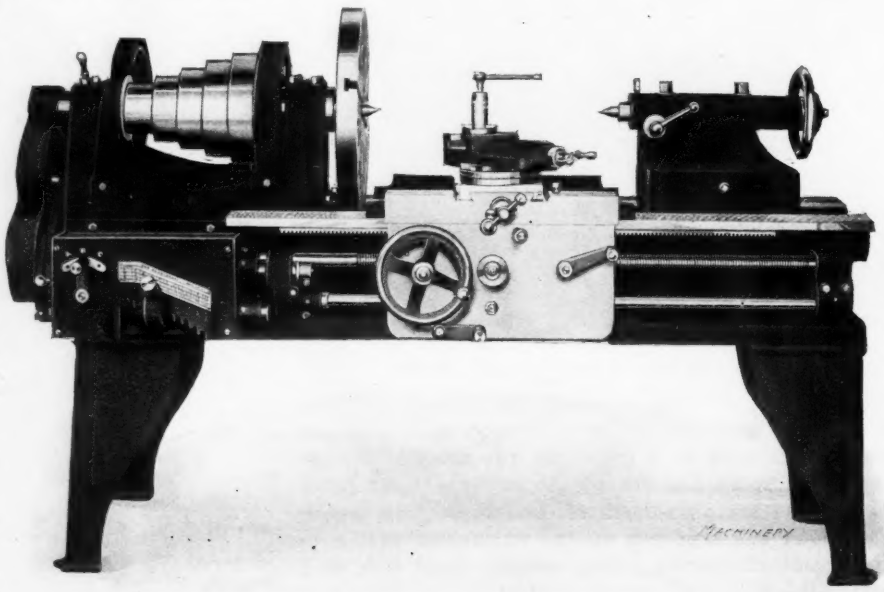


Fig. 1. Rahn-Larmon 16-inch Lathe with Quick Change Gear

The carriage is gibbed to the bed at both the front and back and is provided with a broad bearing for the compound rest. It has a long continuous bearing on the bed and can be firmly locked in place. The compound rest is provided with taper gibs for taking up wear, and the swivel section is so constructed that a long bearing for the tool rest is

provided. The apron is of simple design and all feeds are conveniently controlled. The machine shown in Fig. 1 is equipped with a quick-change gear, and a better illustration of the change gear is shown in Fig. 2. The quick-change screw cutting and feed mechanism is of very simple and substantial construction. Thirty changes of feed are obtained by shifting only two levers and these changes can

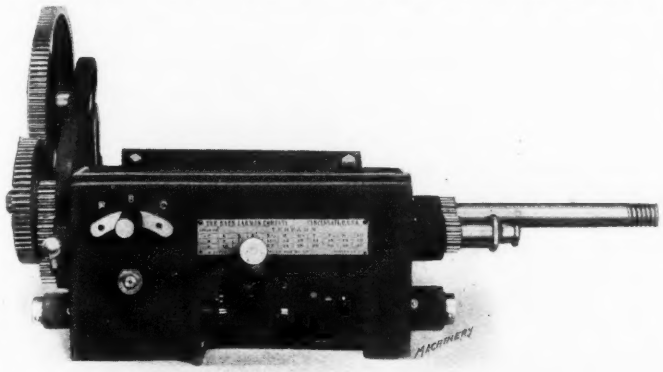


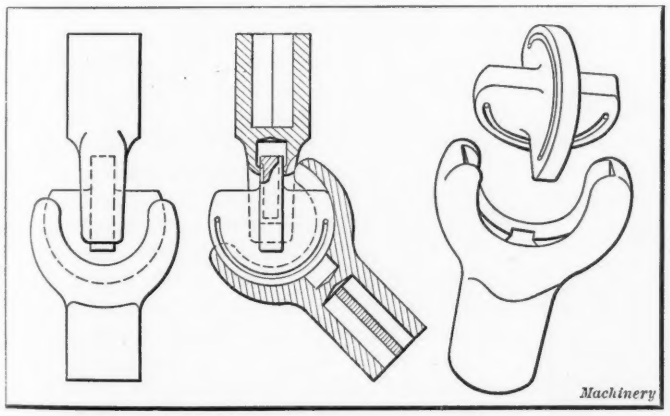
Fig. 2. Quick Change Gear Unit for Rahn-Larmon Lathe

be made instantly while the lathe is running. The gears are steel, the shafts are accurately ground and all bearings are bronze bushed. The gearing at the end of the headstock is so arranged that metric or special feeds can be cut by the substitution of the proper gears. Screw chasing dials are provided which obviate the necessity of reversing the spindle when chasing threads.

The regular equipment of the lathe includes a countershaft, steadyrest, follow-rest, large and small faceplates, wrenches and a screw cutting dial. A taper attachment, a turret for the carriage, a turret for the bed, cabinet legs, chucks, chuck plates and special tool rests can also be obtained. In addition to the form shown in Fig. 1, the lathe is also built without the quick-change gear device.

PLANK UNIVERSAL JOINT

A universal joint of simple but strong construction is a recent product of the Plank Flexible Shaft Machine Co., 234 Ionia St., N. W., Grand Rapids, Mich. This universal joint is



Plank Universal Joint and Details of the Yoke and Center

composed of three parts—two yokes and the center. It interlocks and disengages at 45 degrees and can be disconnected at two points. The bearing surface is said to be from 300 to 400 per cent greater than that of any other universal joint now on the market and the use of screws, pins or rivets is eliminated.

The center block, as shown in the accompanying illustration, consists of one piece of chrome-nickel steel, drop-forged and machined to accurate dimensions and then heat-treated and polished. The yokes are made of high-carbon steel and they are also drop-forged before machining. The simplicity and rigidity of the construction of this universal joint make it particularly well adapted for use on automobile propeller shafts, multiple spindle drilling machines and a variety of other uses where a universal joint is required to transmit motion under severe conditions of service.

BRISTOL PNEUMATIC RECORDING TACHOMETER

In many lines of industrial work it is desirable to keep machinery running at a specified rate of rotation, and in other cases it may be necessary for stops to be made periodically. Recording tachometers are used to furnish the superintendent or manager of the plant with information concerning the way in which the machines have been operated. A case in point is the blowing engines which supply the draft to blast furnaces; these engines are driven at a predetermined number of revolutions per minute, but they are

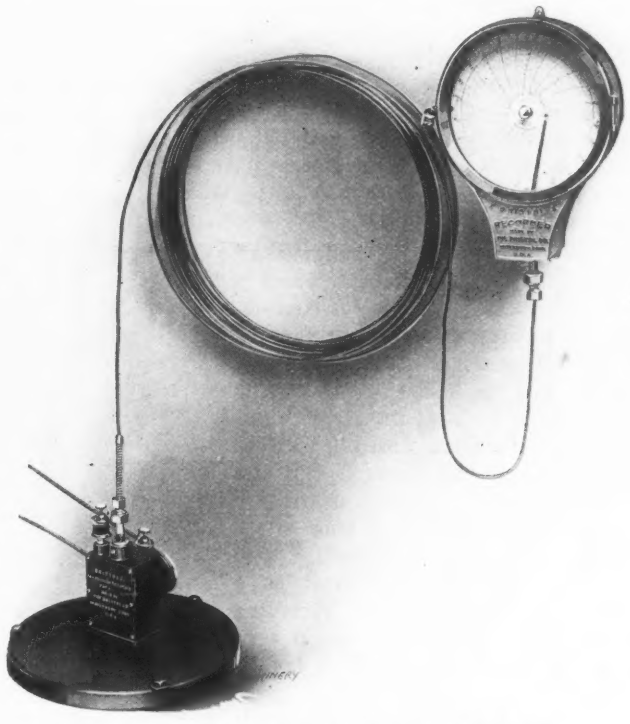


Fig. 1. The Bristol Pneumatic Recording Tachometer

usually slowed up once every twenty-four hours when the casting is done.

The Bristol Co., Waterbury, Conn., is now manufacturing the pneumatic type of recording tachometer illustrated in Fig. 1, which has been developed to afford a means of keep-

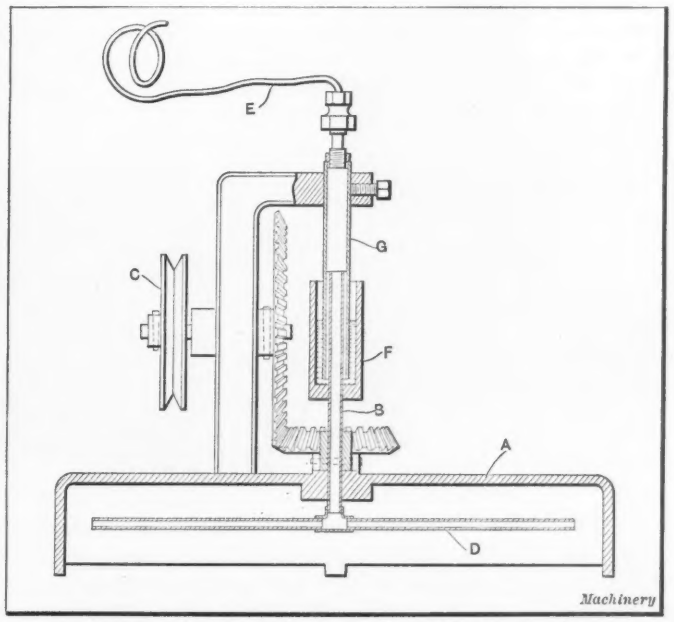


Fig. 2. Diagram showing how the Tachometer operates

ing a record of the rotative speed at which machines are operated, as outlined in the preceding paragraph. These tachometers are used extensively in connection with blast furnace blowing engines, for recording the speed of paper machines, and for similar purposes. In many cases it is not

convenient to have a self-contained recording tachometer located near the revolving shaft, and one of the important features of the new Bristol instrument is that the flexible connecting tube may be twenty-five feet in length or longer, thus allowing plenty of room between the revolving mechanism and the recording instrument. The recorder may be mounted in any convenient position, as, for instance, on a switchboard or the wall of the engine room. The pneumatic principle of operation depends on the centrifugal action of air in a revolving tube which is connected to the recording instrument through an oil sealed flexible connecting tube. Fig. 2 illustrates the construction of the revolving mechanism and shows how the tachometer operates. In this diagram *A* is the base which supports a bearing on its upper surface for the hollow shaft *B*. This shaft is rotated from the member whose angular speed is to be measured by means of the pulley *C* and bevel gears as shown in the illustration. In practice, it is generally found more convenient to drive the tachometer by means of a special form of sprocket and chain in place of the pulley *C* and a belt running over it to the shaft whose revolutions are to be counted.

At the lower end of the hollow shaft *B* there is a horizontal tube *D* which is open at the ends; the tube *D* connects with the recording instrument through the hollow shaft *B* and the flexible tube *E*. The upper end of the shaft *B* is surrounded by a casing *F;* this casing is partially filled with oil, and the free end of a second casing *G* dips into it. The casing *G* remains stationary and the flexible tube *E* leading to the recording instrument is connected with it. The recording instrument is a special low range Bristol recording vacuum gage. When the tube *D* revolves in the casing *A*, the action of centrifugal force tends to throw the air out of the ends of the tube *D*, thus creating a vacuum which actuates the gage. As the magnitude of centrifugal force is dependent upon the rate of rotation, it will be evident that the gage can be graduated to show the number of revolutions per minute.

Fig. 2. Detrick & Harvey Drilling Machine showing Table, Spindle, etc.

DETRICK & HARVEY HORIZONTAL DRILLING MACHINE

The accompanying illustrations show a machine designed for heavy drilling operations with high-speed drills, which is a recent product of the Detrick & Harvey Machine Co., Baltimore, Md. The general design follows the lines of a horizontal boring and drilling machine of the traversing column type having a fixed work table, a column traversing horizontally on the runway and a saddle traveling vertically on the column.

The spindle of the machine is made of hammered high-

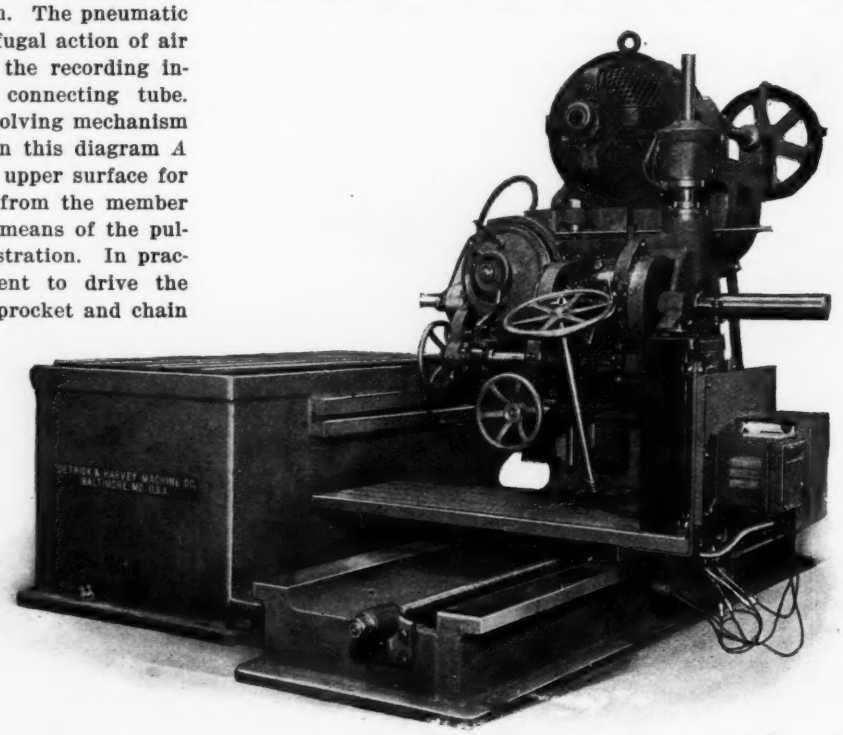


Fig. 1. Operating Side of the Detrick & Harvey Horizontal Drilling Machine

carbon steel with a tapered front bearing 7⅞ inches in diameter, the bearing being bushed with phosphor-bronze and provided with means for compensating for wear. The thrust is taken by a dust-proof roller thrust bearing and the spindle has a standard taper socket. The main body of the spindle is 4 inches in diameter. Power is provided by a 4 to 1 variable-speed, 20-horsepower motor which is mounted at the top of the column. All driving gears are of cast steel or manganese bronze and the pinions are of high-carbon steel. The range of spindle speeds is from 60 to 240 revolutions per minute and no belts or chains are used in driving the spindle or feed mechanism. The power feed is driven from the spindle sleeve gear; and the feed mechanism is equipped with all-steel gears and clutches, with a steel pinion engaging a rack cut from solid steel on the feed quill. Four changes of feed ranging from 0.004 to 0.090 inch per revolution are provided.

The vertical movement of the saddle and the horizontal movement of the column are obtained through handwheels conveniently located within reach of the operating platform. The column is mounted on rollers to reduce friction on the runway to a minimum. Both the saddle and column may be easily changed to any required position and have gibs for taking up wear. The controller for the motor is also mounted on the operating platform, thus providing complete control of the machine from a single position. An oil jet is provided for the drill, the oil being delivered by a rotary pump driven by a small auxiliary motor. The work table is provided with a channel around all four sides, by means of which the oil is returned to the supply tank of the pump, thus eliminating all waste. The high table provided on this machine enables the spindle to be brought down within 3 inches of its surface; the vertical adjustment of the head on the column is 12 inches and horizontal adjustment of the column on the bed is 6 feet. The machine can be made in various sizes to meet the requirements of individual cases.

PRATT & WHITNEY DIE-SINKING MACHINE

The duplex die-sinking machine shown in Fig. 1 has recently been developed by the Pratt & Whitney Co., Hartford, Conn., to supplement its smaller sizes of die-sinking machines. The present machine differs from the smaller sizes in that the head is made the movable member. The reason for this change in design is that the weight of the dies for which this machine will generally be used is so great that it was considered inadvisable to adopt a construction that would make it necessary to elevate the table and work. The machine has a wide range and is of unusually heavy construction. The design includes several new features, among which may be mentioned the duplex spindle construction, the method of feed control and other points which will be referred to in detail in subsequent paragraphs. These features add greatly to the efficiency of the machine and make it particularly well adapted for finishing large forging dies in an economical manner. The bearing surface on the column, on which the head is mounted, is of liberal proportions, tapered gib adjustments being provided to compensate for wear. The head is accurately counterbalanced, and is raised or lowered by a handwheel *A*, which is connected with the elevating screw *B* by means of bevel gears. A micrometer dial enables the travel to be accurately controlled, and, in addition, a positive vertical stop *C* is provided. A powerful binding device controlled through the handle *D* permits the head to be clamped at any desired point.

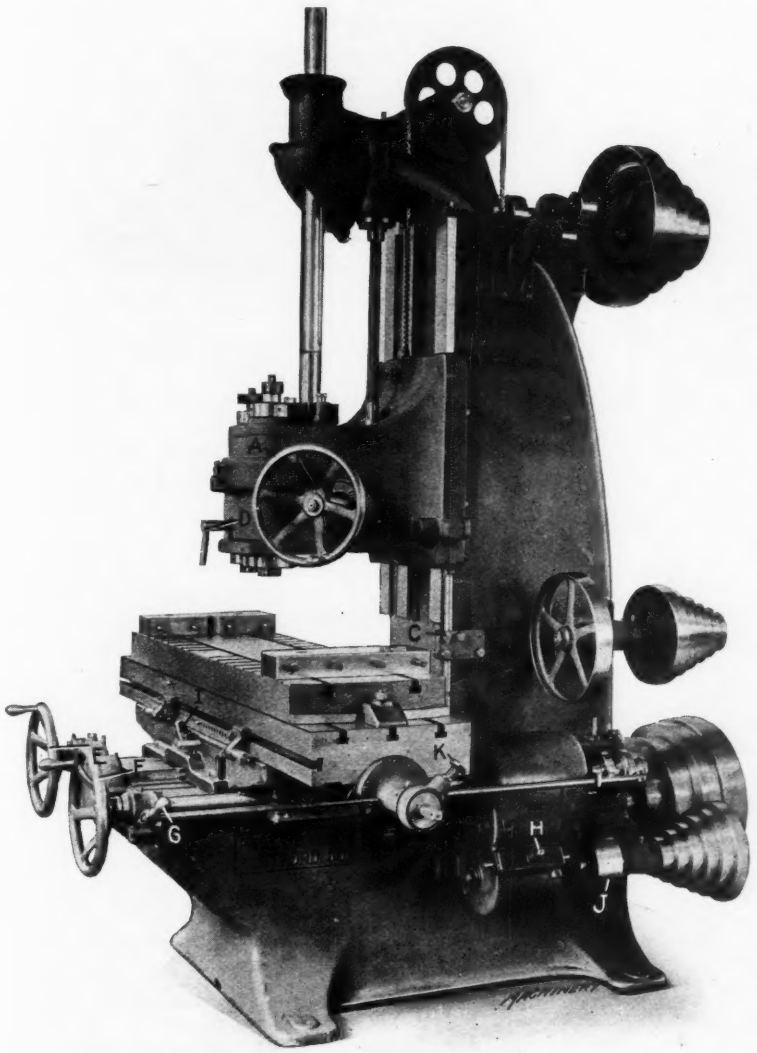


Fig. 1. Pratt & Whitney No. 4 Duplex Die-sinking Machine

It will be seen that the machine is provided with two spindles, one of which is considerably larger than the other. The value of this construction lies in the fact that on large die work it is frequently necessary to take finishing cuts with cutters of small diameter, requiring a high spindle speed. It was found that a spindle of sufficient size to stand up under the heavier cuts which are required of this machine could not be provided with a sufficient range of speeds to drive small cutters satisfactorily. With the two spindles, speeds ranging from 44 to 640 revolutions per minute are obtainable, which makes the machine equally efficient on both light and heavy cuts. The spindles are made of special steel and mounted in bronze bushed cylindrical bearings, which have conical seats in the heads and means for compensating for wear. Both the spindles are located in the same plane and are not adjustable vertically. The large spindle is provided with a tapered hole of the same dimensions as that of the spindle of the No. 3 die-sinking machine built by the Pratt & Whitney Co., and the small spindle corresponds to the spindle of the No. 2 die-sinking machine of this company's manufacture. Both spindles are provided with pull-back rods for holding the cutters securely in place. A simple but efficient spindle locking device is also provided for holding the spindles stationary while tightening the cutter chucks. Each spindle is provided with eight speeds by means of a four-step cone pulley and a two-speed countershaft. A vertical shaft driven from the cone by means of bevel gearing transmits the power directly to the larger spindle through spur gearing. The small spindle is driven through gearing from the large spindle and the drive may be engaged or disengaged at will.

Both the saddle and table are of unusually heavy construction, liberal bearing surfaces being provided, with tapered gibs for making the necessary adjustments. Either the saddle or the table may be positively clamped at any point by means of binders provided for this purpose. The table has hand transverse feed, and both hand and power longitudinal feeds. The transverse feed is controlled through the handwheel *E*, the hand longitudinal feed through the handwheel *F*, and the power longitudinal feed through the lever *G*. The handwheels on the front of the machine are widely separated with a view of enabling the operator to get near to the work when necessary. Micrometer dials are provided to enable the adjustments to be accurately gaged. The power feed is operative in either direction, the lever *G* being pushed in or pulled out, according to the direction in which the table is to travel. In order to meet the diversified requirements of the machine, a liberal range of feeds has been provided. The feed mechanism is contained in a compact unit located at the right-hand side of the machine and is so constructed that two gear ratios are obtainable by means of sliding gears which act in conjunction with the six-step feed cones to give twelve changes of feed. The sliding gears are operated by the handle *H*.

The travel of the table is controlled by means of positive stops, this method being preferable to the ordinary automatic knock-outs, due to the fact that in sinking forging dies the operator always works to a line. It can readily be seen that it would be quite impossible to provide an automatic device which would be sufficiently accurate for this purpose. The stops are carried on the side of the table, suitable locating places being provided which act in conjunction with ordinary binders to prevent the stops from slipping. Furthermore, micrometer screws are provided which make it possible to obtain very delicate adjustments. Should the operator neglect to disengage the feed, the stop will engage the abutment *I* on the saddle, thus stopping the table. The friction through which the feed is controlled will slip under these conditions, preventing damage to the machine. Ordinarily, the operator would disengage the feed a trifle before the cutter reaches the line on the work, and then bring the table up to the micrometer stop by hand. The feed friction referred to is enclosed in a case *J* and is sufficiently powerful to provide adequate feed under all working conditions. In addition to the regular feeds, the table is provided with a quick hand return. This movement is obtained by releasing the lock-bolt *K* and rotating the feed-screw by means of a crank, the end of the screw being squared for this purpose. In the operation of the regular feeds, the screw remains

stationary and the nut rotates, which makes it possible to obtain a very rapid return by rotating the screw.

The plain vise which forms a part of the regular equipment of this machine extends practically the full length of the table. The top of the vise is provided with suitable locating places for the accommodation of the jaws; and the vise is pivoted at the center, allowing it to be swung to an angle of 15 degrees in either direction from the center. The machine may also be provided with a circular vise which is mounted directly upon the table. The rotary hand feed is transmitted through a worm and worm-wheel. Fig. 2 shows the cherrying attachment set up in the operating position, and Fig. 3 shows a larger view. It will be seen that the attachment is

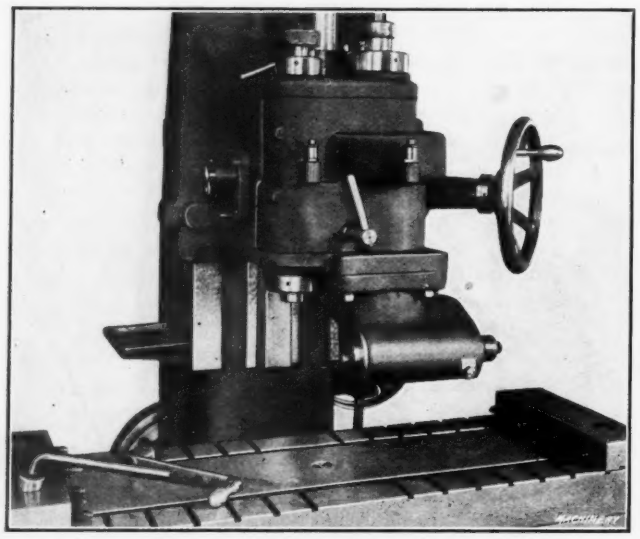


Fig. 2. Cherrying Attachment set up on Pratt & Whitney Die-sinking Machine

clamped to the under side of the head, being located by and driven from the large spindle. It may be swiveled and securely clamped in four different positions, *i. e.*, the horizontal spindle can be located in the most desirable position to operate upon the die that is being machined. The spindle of the attachment is provided with the same taper as the large spindle of the machine. Chucks for straight shank cutters are provided for use on this machine. These chucks are of rugged construction, being made of hardened steel and finished by grinding. They are made in sizes suitable for use in either the large or the small spindle.

The machine described in the preceding paragraphs is known as the No. 4 size, and its capacity is as follows: size of top of table, 18 by 72 inches; longitudinal travel, 30 inches;

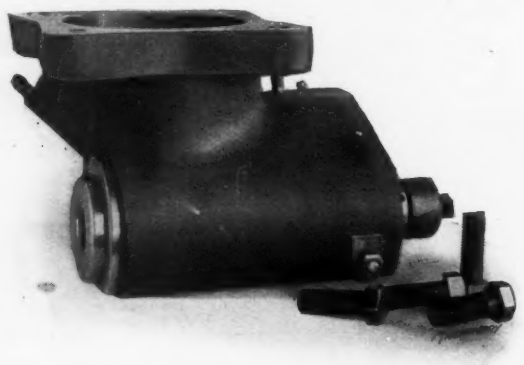


Fig. 3. Cherrying Attachment shown in Fig. 2

transverse travel, 16 inches; maximum distance from table to spindle, 28 inches; vertical movement of head, 20 inches, and maximum opening of plain vise, 52½ inches.

WATSON-STILLMAN HYDRAULIC STRAIGHTENING PRESS

The Watson-Stillman Co., 192 Fulton St., New York City, has recently added to its line the hydraulic straightening press shown in the accompanying illustrations. This machine has a capacity of 325 tons, which is sufficient for straightening steel shafts up to 10 inches in diameter; and the only limit to the length of the shaft is the extent of the foundations provided. By referring to Fig. 1, it will be seen

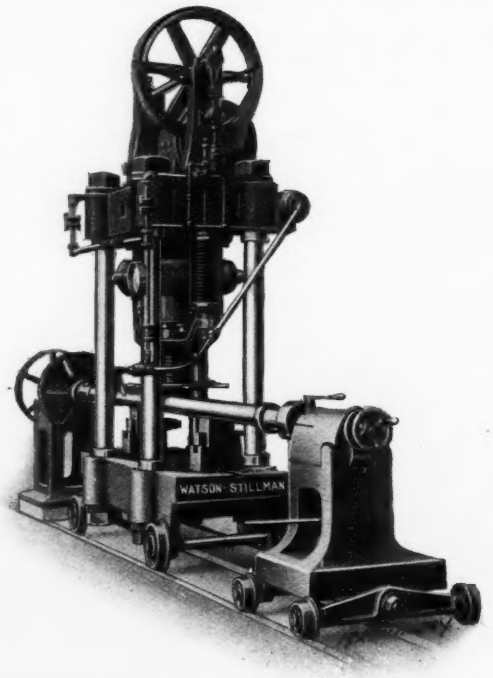


Fig. 1. Watson-Stillman Hydraulic Straightening Press in Operation

that the press is a motor-driven self-contained unit requiring no outside air or hydraulic system. There are three independent parts to the equipment—the headstock, which is stationary, and the press and tailstock, which are mounted on rollers to permit of their adjustment for straightening

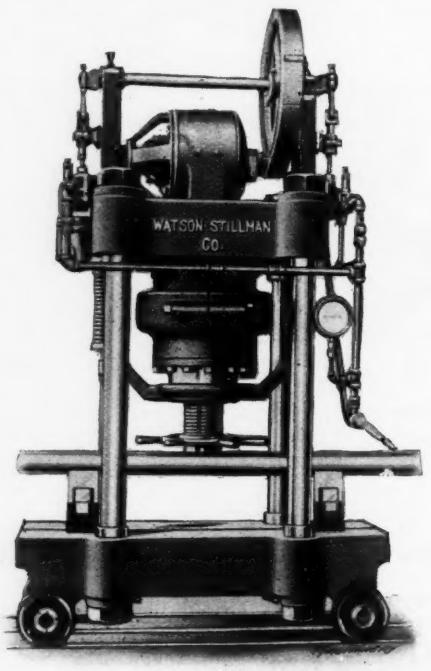


Fig. 2. Front View of the Watson-Stillman Press

shafts of various lengths. The bed rails are set flush with the floor so that when the movable parts are not in use, they can be rolled to one side, leaving the floor clear of obstructions. The head and tailstock are similar to those of a lathe except that the centers are hinged to follow the movement of the ends of the shaft while the shaft is bending.

The shaft is rotated from the headstock and the high point noted. The press is then moved to that point and the bending blocks adjusted. The ram has a maximum movement of 2 inches, and a square thread adjusting screw is mounted concentrically in it, as shown in Fig. 2. This provides for making adjustment for the different diameters of shafts

straightened in the machine, and also enables the operator to predetermine the flexure desired. In this way, all danger of over-bending is eliminated. The entire hydraulic power plant, including a five-horsepower motor, pump, reservoir, etc., is mounted on the top of the platen of the press. The floor space required is 3 feet 6 inches wide by the length of the shaft to be straightened plus six feet. The total weight of the press is 19,300 pounds.

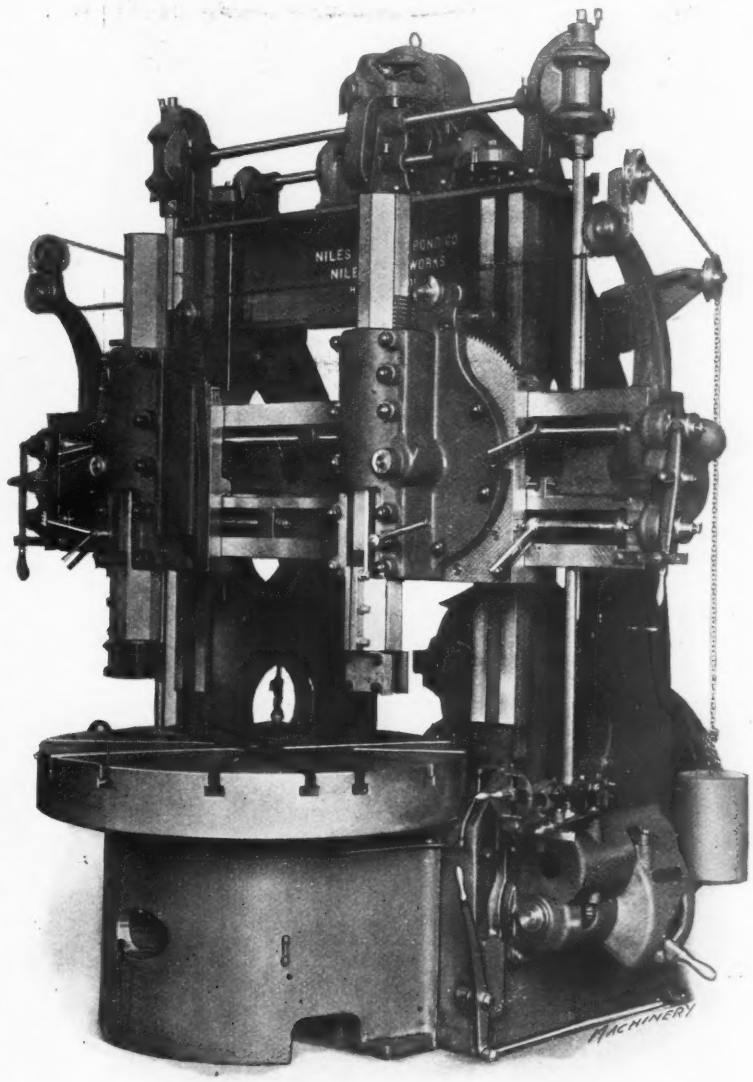
NILES BORING AND TURNING MILLS

The accompanying illustration shows the 53-inch size of a line of boring and turning mills which has recently been placed upon the market by the Niles-Bement-Pond Co., 111 Broadway, New York City. In the design of these machines, particular care has been paid to the development of features which add to the convenience of operation, thus increasing the output of the machine and operator. The levers for all changes of feed and reversal, rapid power traverse or hand adjustment of the saddles and bars, cross-rail adjustment and table control are within easy reach of the operating position. One lever disengages the feed, engages the fine and coarse feed and operates the rapid traverse in either direction. Rapid power traverse to the saddles and bars in either direction is provided and also hand adjustment of the saddles and bars by automatic releasing ratchets located at the sides of the saddles. The machine is entirely self-contained, no part extending below the floor line and no special foundation being required.

The housings are of the box girder form with broad faces which have no openings in the front of them. The cross-rail elevating screws are located between the housings. The table is strongly ribbed and supported by an annular bearing which is kept flooded with oil. The table is driven by a coarse pitch bevel gear, which is accurately cut and of wide face. The surface of the table has two pairs of parallel and eight radial T-slots. The table is maintained in strict alignment by an upper and lower bearing. The upper bearing is bored from the solid bed and fitted with an adjustable taper bushing to compensate for wear. The lower bearing is bronze bushed and there is an adjustable threaded collar on the end of the spindle to prevent lifting.

The cross-rail is of the three-track type. It has a narrow guide at the bottom with the saddle traversing screw located between the guiding surfaces. The cross-rail is of the box girder form and made of exceptional depth to enable it to resist the strains resulting from heavy cutting. It may be readily clamped to the housings in any desired position, and power adjustment is provided. The saddles have wide bearings on the cross-rail, which are accurately scraped and provided with tapered gibs to compensate for wear. A clamping bolt provides for clamping each saddle while the bar is feeding. The bars are octagon shaped steel forgings which are scraped to a bearing on four sides. Eight changes of positive feed are available; the feeds are reversible and independent for each head, both in amount and direction. The tool-holders are steel forgings provided with means for readily clamping the tools for boring, turning and facing operations. The tool-holders have straight shanks and are readily removed to provide for the insertion of special boring bars. Counterweights for each bar are attached to the same chain, but act independently of each other, and will not pull the swings over nor interfere with the movement of the saddles. The counterweight chain is placed at the rear of the bars to prevent interference with an overhead crane when moving work on or off the table of the machine. Safety friction clutches located on the vertical spline shafts insure against accidents in case the heads or bars meet with an obstruction while feeding or traversing.

Where direct current motor drive is employed, a four to one variable speed motor carried on the plate located between the housings at the rear of the machine is employed. Power is transmitted through a double run of clutch gears giving two mechanical changes of speed, which, in connection with the sixteen or more speeds in the controller, affords thirty-two or more speeds to the table. The motor is fitted with a push button control and a dynamic brake for the table. An auxiliary motor located on the top brace of the mill is furnished for elevating the cross-rail and operating the rapid power traverse for the bars and saddles. Belt drive through a single pulley or alternating current motor drive from a constant speed motor may also be employed. In this case, the drive is through a speed-box and back gear located at the rear of the mill, twelve changes of speed being provided. The speed-box is fitted with a hand operated friction clutch for starting or stopping the table, and a brake is provided that is controlled by the same hand lever which operates the clutch. Belt driven machines are built



Fifty-three-inch Niles Boring and Turning Mill

on the convertible plan and may be readily changed over for motor drive, if so required. This line of boring and turning mills is made in four sizes which have actual swings of 44½, 54, 63 and 74½ inches.

KELSEY DRAFTING TABLE

A great deal of attention is now being paid to the development of convenient methods of controlling machinery and other factory equipments, so as to reduce the effort required of the operator and increase his efficiency. In the case of the draftsman, improved methods of control of this kind are particularly valuable, as the reduction of fatigue means that he is at his best both mentally and physically, which is particularly important in striving for the best results in drafting. The Kelsey drafting table illustrated in this connection is equipped with a special form of ruling

edge, which is more convenient to use than the regular form of T-square, thus reducing fatigue and increasing the draftsman's efficiency.

The design of the table may be briefly described as follows: a drawing-board holder, consisting of two castings mounted on a rocker shaft, has the drawing-board clamped between wooden front and back pieces by means of thumbscrews. The ruling edge or blade works independently of the edges of the board, and the way in which it is supported

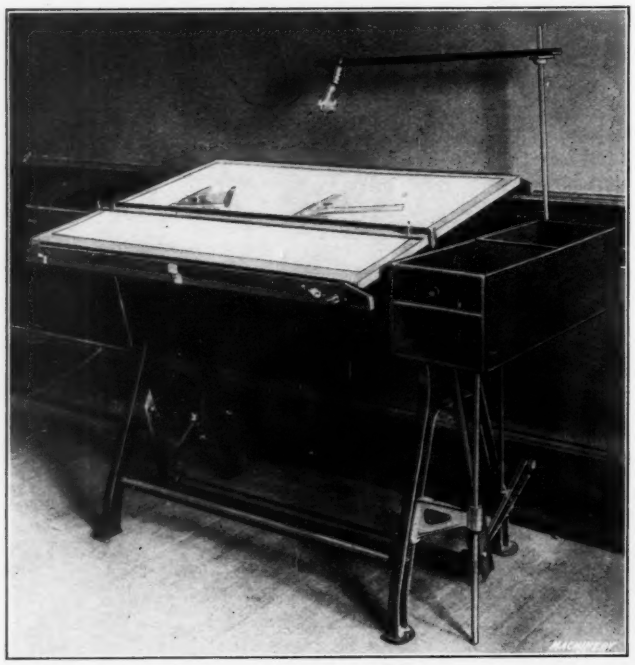


Fig. 1. Kelsey Drafting Table with Blade in Operating Position

allows the draftsman to work with greater ease and rapidity than he could with an ordinary T-square. The blade is carried by a pivoted support which is almost counterbalanced by springs at either end of the table, the slight excess of weight being carried by a finger bar secured to the blade. The support is hung from a rocker shaft and so adjusted that a slight lift raises the blade a considerable distance

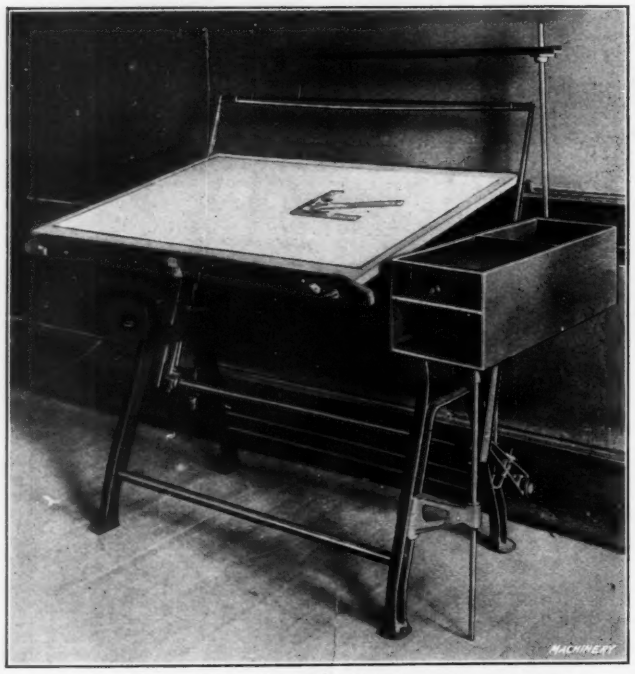


Fig. 2. Kelsey Table with Blade lifted up from the Paper

above the drawing-board, where it is held stationary until it is again wanted. This feature is particularly convenient when applying tracing cloth or changing drawings on the board. As the blade is practically balanced and can be moved into any desired position over the board by means of the finger bar, the convenience of the arrangement will be apparent. This device can be supplied as an attachment for use on any substantial table, in which case the support for the blade is mounted above the table.

The illustrations show the draftsman's universal square and protractor, which is a product of the same maker, in place on the table. This instrument affords a particularly efficient means of drawing horizontal, vertical and angular lines. The instrument is made in various sizes. It will also be seen that a cabinet is attached to the table. This cabinet has a drawer 7½ by 13 by 1¾ inch in size, a pocket 8 by 12 by 3 inches in size and a pigeon hole for holding rolled up tracings, which is 8 by 4 by 27½ inches in size. An upright for holding a light is also shown in the illustration. This drawing-board is a recent product of D. J. Kelsey, 77 Livingston St., New Haven, Conn.

WEBSTER & PERKS FLOOR TYPE GRINDER

The floor type grinder illustrated herewith is a recent product of the Webster & Perks Tool Co., Springfield, Ohio. The machine is driven by a five-horsepower alternating-current motor which is adapted for use on a sixty-cycle circuit and runs at 1150 revolutions per minute. The rotor is wound on a hollow steel shaft mounted in ball bearings, and the arbor of the machine passes through this hollow shaft, from which it is driven by a pair of dovetail steel keys. As the

Webster & Perks Motor-driven Floor-type Grinder

arbor is of smaller diameter than the hole in the rotor shaft, any ordinary deflection of the arbor cannot throw the rotor out of alignment and cause it to strike the fields. The arbor may be removed from the machine without in any way disturbing the motor. The arbor bearings are independent of the rotor bearings, being babbitted and provided with the self-oiling feature applied in the bearings of other machines of this company's manufacture.

The principal dimensions of this grinder are as follows: capacity for handling wheels, 16 or 18 inches in diameter by 3 inches face width; height from floor to center of arbor, 33 inches; size of base, 22 by 38 inches; and net weight of machine with motor, 1550 pounds. The machine is shown equipped with the exhaust type of wheel-guards which may be removed if necessary.

WOOD STOCK CONTROL CHUCK

The Wood Turret Machine Co., Brazil, Ind., is now equipping all its tilted turret screw machines and turret lathes with a new chuck; a machine equipped in this manner is illustrated in Fig. 1, and Fig. 2 shows a cross-sectional view of one of the chucks, from which the construction will be better understood. Referring to this illustration, it will be seen

that three grooves *A* are provided to keep the cutting compound from working into the spindle bearings. The holes *B* are provided to receive a spanner used in adjusting the chuck; *C* is the collet master or collet closing ring, and *D* is the collet. The spindle is recessed at the end to receive the collet closing ring *C*, this recess being ground to size by the use of a special fixture which is employed after the spindle is assembled in the bearings. This insures a more perfect and concentric bearing for the ring than could otherwise be obtained. The ring is hardened and ground both internally and externally, the internal opening being tapered to fit the nose of the collet.

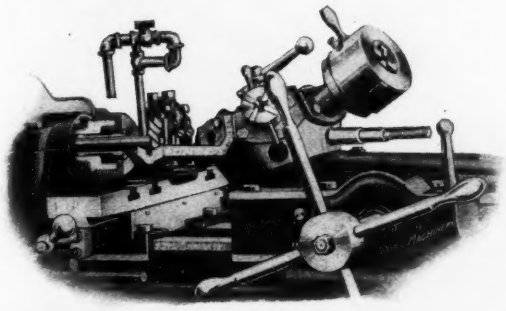


Fig. 1. Machine equipped with the Wood Improved Stock Control Chuck

In the old form of chuck in which the holder is screwed onto the spindle, the rear face of the chuck is so far removed from the point where the work is held that any slight variation between the chuck and spindle causes the work to be thrown materially off center. The necessity of frequently detaching the chuck from the threaded spindle causes the thread to become worn, with the result that lost motion develops between the chuck and spindle which causes a corresponding inaccuracy in the work. Furthermore, it was necessary to heat-treat a chuck of this style which resulted in distortion of the thread with a corresponding inaccuracy in the alignment of the work held in the chuck.

These objectionable features are entirely eliminated in the new Wood stock control chuck by simply mounting the collet in the spindle and centering it by means of the collet master *C*, which is hardened and then accurately ground. The master, in turn, is controlled by the hood on the end of the spindle, the hood keeping it from being pushed forward. With this construction the engagement of the hood with the spindle may be out of alignment without in any way affecting the alignment of the collet master and the collet. The collet master remains stationary when the chuck is in operation in chucking or unchucking the work. All wearing parts are hardened and ground.

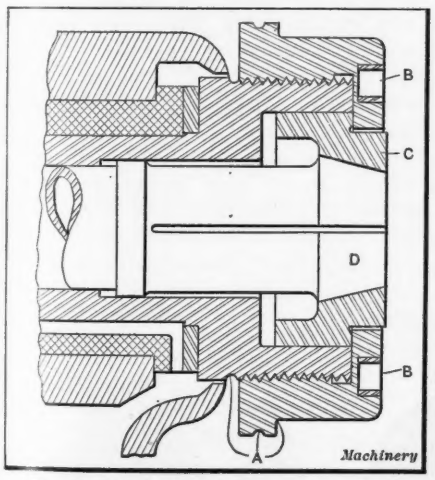
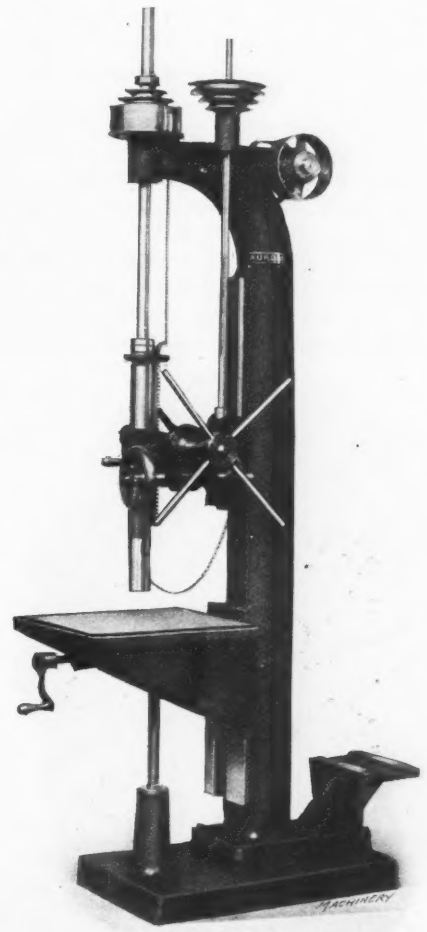


Fig. 2. Cross-sectional View of the Chuck

AURORA HIGH-SPEED DRILL

The high-speed drill equipped with both hand and power feed, an adjustment of 14 inches for the slide, 14 inches travel for the head and 14 inches adjustment for the table has recently been brought out by the Aurora Tool Works, Aurora, Ind. A number of these drills were built for use in the plant of the Fort Wayne Electric Works of the General Electric Co., according to specifications furnished by the mechanical superintendent. The machines are designed for heavy work in driving multiple spindle drill heads of the Langelier and similar types in which as many as eight ⅜-inch drills are working simultaneously.

The drive is provided by a direct-current Fort Wayne motor mounted on a bracket on the base of the machine. The illustration shows the bracket provided for this purpose, but it will be seen that the motor is not in place on the machine. For the particular class of work for which these drills were built, a constant-speed motor is used, driving the spindles at 1800 revolutions per minute. If a range of speeds was required, however, a variable-speed motor could be employed or the motor bracket could be replaced by a bracket supporting a cone pulley. Three changes of feed are secured through the feed cone pulleys at the top of the machine,



Aurora Ball Bearing High-speed Drill

the available feeds being 0.0035, 0.007 and 0.010 inch per revolution. The pulleys are mounted in ball bearings and the spindle is equipped with a ball thrust bearing, which reduces friction losses to a minimum.

G. E. CONTINUOUS CURRENT GENERATORS

A new line of engine type, commutating pole, continuous current generators has been recently placed on the market by the General Electric Co., Schenectady, N. Y. These machines embody all the advanced refinements in the electrical and mechanical design of this class of apparatus, which enables them to meet the most exacting service requirements modern applications demand. The generators are offered in the usual complete line of standard sizes ranging from 25 K.W. to 400 K.W., inclusive. They are manufactured in both the two-wire, designated Form LD, and three-wire, known as Form LDS, types, with either shunt or compound field windings and with armatures wound to deliver the rated kilowatt output at any voltage from 115 to 125 volts or 230 to 250 volts. Larger sizes of both types and wound for 250 volts only are built on specification.

The speeds of these generators are in conformity with modern engine practice, and were selected after a careful consideration of the recommendations and requirements of leading engine builders. Compound wound machines auto-

matically compensating for line drop in the distribution system are built for any desired degree of compounding from no-load to full-load, although 4 to 5 per cent is usually sufficient for average conditions, and standard field windings provide for this amount. The frame is designed for installing on the engine bed-plate or masonry foundations, and the armature is bored for mounting on the engine shaft. The utilization of commutating poles in these generators is one of the distinctive features of the new design, and permits operation over an extremely wide range of load and voltage with a fixed brush position and sparkless commutation. The commutating winding produces a magnetic field flowing in a direction that assists the reversal of current in the coil undergoing commutation, and is also directly opposed to the field generated by armature reaction tending to retard the reversal of current in this coil.

The commutating field thus completely nullifies the distortive effect of armature reaction on the main field flux in the commutating zone, and generates an electromotive force that helps the brush to commutate the current without sparking and with a consequent increased life of the commutator and brushes. Inasmuch as the commutating windings are directly in series with the armature, their strength varies directly with the armature current and provides the correct rectifying effect for proper reversal of current in the

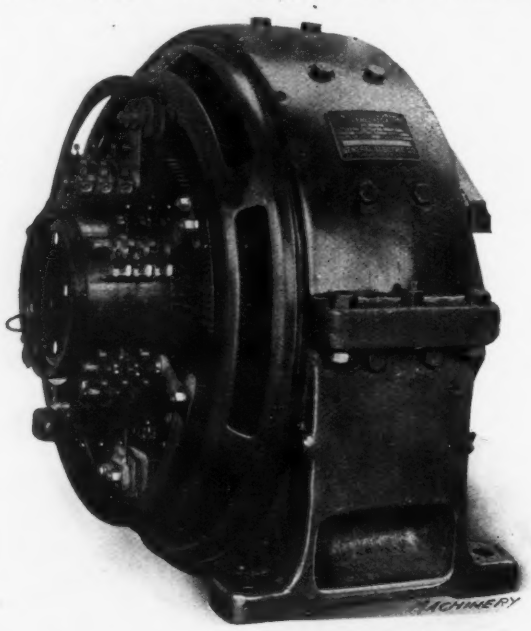


Fig. 1. Two-wire Form LD Engine Type Generator of 35 K. W. Capacity

coils at all loads. Hence it is unnecessary to shift the brushes as the load changes. A new and very important feature of this line of generators is the development of the three-wire machines with a special type of revolving compensator. The advantages of the three-wire system for the distribution of electrical energy at low voltages are well understood. The principal advantage is the fact that a 125/250 volt three-wire system requires about one-third the amount of copper in the distribution system required by a 125-volt two-wire system. Thus the adoption of the three-wire system for a combined lighting and power load saves about two-thirds the investment in copper.

The adoption of the revolving compensator with one collector ring for obtaining the neutral connection with three-wire operation is somewhat of a radical departure from previous designs. This design supersedes the familiar separate stationary compensator and two collector ring arrangement. The revolving compensator consists of a circular magnetic core upon which are mounted suitable exciting coils, the core with its coils being assembled on a cast bracket bolted directly to the back end of the armature spider. The compensator fits under the overhanging end windings of the armature, projecting but a short distance beyond the main winding, and requires no additional allowance in floor space. The compensator windings are connected to the main armature winding at proper points, and the neutral connection is taken through the armature spider to a single collector ring mounted on the outer end of the commutator shell. The neutral brushes bearing on this ring are supported by and insulated from the main brush-holder studs. The simplicity of this design, self-contained with the armature, eliminates floor space taken by the stationary compensator, requires fewer collector rings and brushes, and reduces the number of cable leads to the switchboard.

Revolving compensators may be applied and connected to standard Form LD two-wire armatures. Aside from the

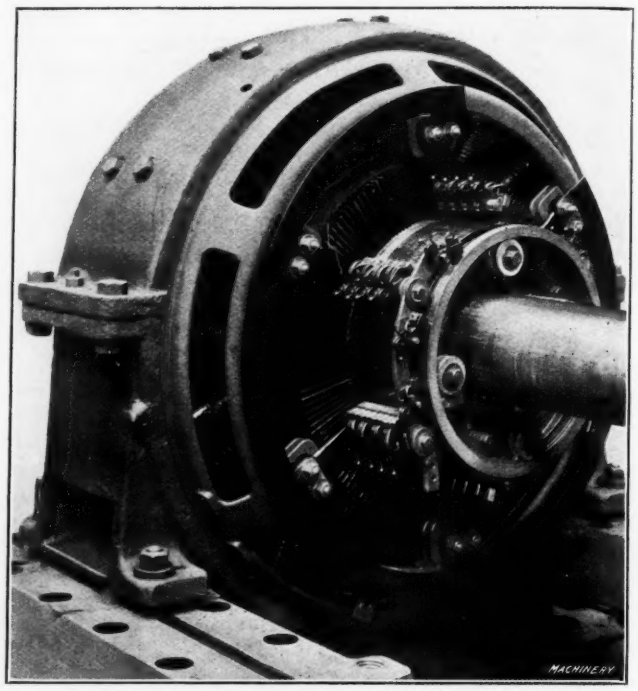
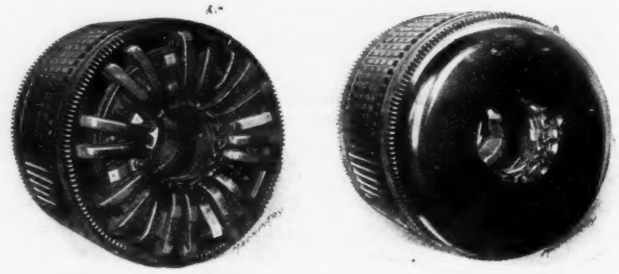


Fig. 2. Three-wire Form LDS Engine Type Generator of 100 K. W. Capacity

armature construction, the only important difference between a two-wire Form LD and a three-wire Form LDS generator is in the field connections. In the three-wire generator the series and commutating fields are equally divided between the two sides (positive and negative) of the armature, insuring exact compounding for all load conditions whether balanced or unbalanced. Three-wire generators are designed to carry on unbalanced current of 25 per cent of the rated full load current in the neutral. Particular attention has been given to the ventilation of these machines. Armature cores, windings, spiders and flanges, commutator shells and all field coils are of the open construction, allowing a free circulation of air through and around all component parts, which insures low temperatures, good efficiency and durability of the insulation. The magnet frame is cast steel split horizontally above the center line, so that the gener-



Figs. 3 and 4. Armature with Revolving Compensator for Three-wire Machine

ator can be taken apart for cleaning, inspection or repair without removing any of the field poles.

The main poles are of laminated steel, punched to suit the finished frame and held in place by bolts. The main field is constructed with the series coil mounted outside the shunt coil, and is separated a sufficient distance to permit thorough ventilation and insure easy access to either coil. The shunt coil is thoroughly insulated on a sheet metal body and is supported by heavy insulating collars. The commutating poles are of rolled steel held in place by bolts, and carry a

helical winding of edgewise-wound copper strip, insuring effective radiation of heat. Either the main or commutating poles with their coils are readily removed without interfering with the magnet frame or brush rigging. The armature windings, either multiple or series as best suits the design, are formed from bar stock in coils of endless type, without joints or clips on the back end; and the design of the coil is such that an exceptionally free circulation of air is obtained around and through the end windings. An improved wrapped type of insulation supersedes the trough type used on previous designs. The windings are held in the slots by hardwood wedges dovetailed in the punchings, and on the ends by binding bands, which do not, however, extend over the core. The end connections are supported by flanges bolted to the armature spider. Suitable equalizer connections are provided on all multiple wound armatures to prevent any difference in voltage due to variation in the air gap, and also to equalize the magnetic pull on the shaft.

The commutator segments are made of liberal depth, from hard drawn copper, insulated from the shell and from one another by mica gaged to uniform thickness and of such hardness as to wear evenly with the copper. On the smaller sizes the back clamping rings are cast integral with the commutator shell, the outer clamp ring being a separate casting. On the larger sizes both clamping rings are separate castings. The commutator segments are of sufficient length to permit staggering the brushes, which insures even wear of the entire commutator surface. The commutator is supported independently of the shaft, being mounted on an extension of the armature spider. The segments are connected to the armature winding by copper strips soldered into the segments and to the armature conductors. The armature core is built up of thin laminations thoroughly annealed, assembled and keyed to a finished seat on the armature spider. Through bolts hold the assembled core in place between two cast-iron flanges, one of which is cast integral with the spider. These bolts are located within the inner periphery of the punchings and do not pass through the core. A liberal number of radial air ducts is provided to insure good ventilation.

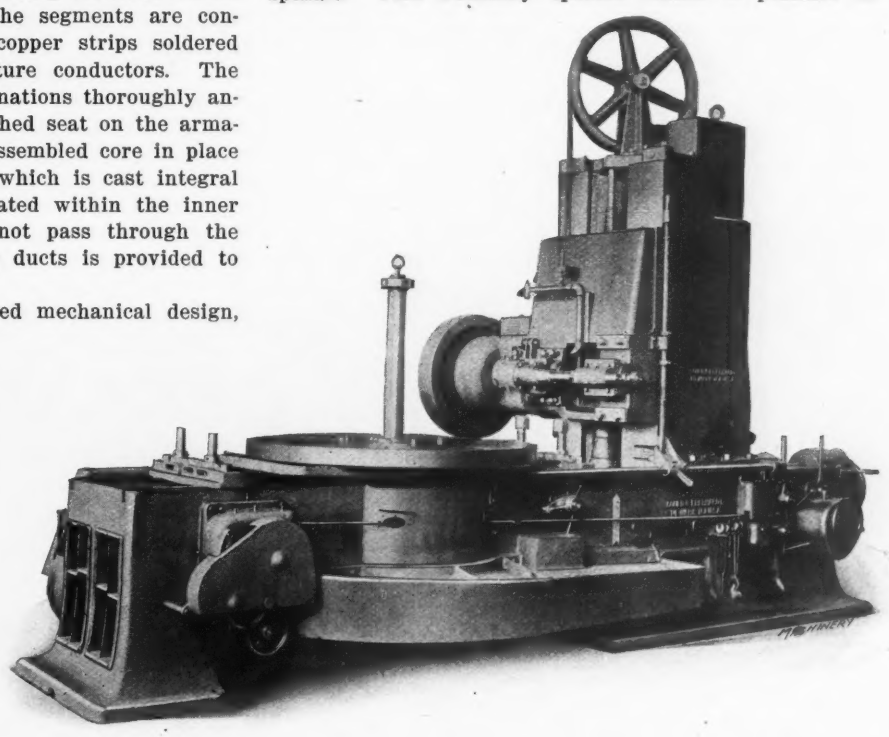
The brush rigging is of an improved mechanical design, the yoke fitting closely in a groove turned in the magnet frame. The brush-holder brackets are firmly attached to the yoke and are made adjustable to allow for natural wear of the commutator. The brush-holder studs are riveted in the brackets and are supplied with a liberal number of brush-holders. No shifting device is furnished nor required. After the brushes are once adjusted in their proper position, the yoke is locked in place and no further brush shift is necessary. The design of the brush-holder embodies distinctive features. The brush-holder body is a single-piece brass casting bored for the stud fit, while the broached box offers a long bearing surface that eliminates grooving of the brush. The punched steel lever is rigid and maintains its relation to the brush irrespective of wear. Tension is obtained by a steel wire spring, the design allowing a wide range of adjustment for brush pressure. A metal cap riveted to the brush avoids wear at the point of contact with the spring lever. A flexible copper connection with ample contact surface is supplied for carrying the current to avoid deterioration of the brush-holder spring.

Connection blocks are bolted to the under side of the magnet frame. To these are fastened the machine leads, which are fitted with suitable terminals for receiving the line cables. While commutating pole generators are superior to non-commutating pole generators for any character of service, these machines with their many additional improvements in design will operate in a thoroughly satisfactory and reliable manner under the most severe service conditions, where fluctuating motor loads frequently predominate, such as for lighting and power service in office buildings, industrial plants, mines, and other classes of service.

GOULD & EBERHARDT AUTOMATIC GEAR-CUTTING MACHINE

Gould & Eberhardt, Newark, N. J., have recently built the automatic gear-cutting machine which forms the subject of this article for Foote Bros., Chicago, Ill. The machine is of exceptionally large size, having a capacity for cutting spur gears up to 144 inches in diameter by 24 inches face width. Steel gears up to 4 inches circular pitch can be handled by the machine. This automatic gear-cutting machine is of the vertical cutting type, and owing to the exceptionally heavy gears for which it is designed, the indexing worm-wheel is mounted in a fixed position and the stanchion carrying the cutter-slide is adjustable by hand or power to accommodate gears of various diameters and also for setting the machine for the required depth of cut.

The cutter spindle is driven by a powerful worm and worm-wheel, and a heavy flywheel is mounted at the end of the main spindle to compensate for any inequality in the work or any other cause which might tend to make the speed of the cutter fluctuate. The cutter spindle is 3 inches in diameter and will take cutters up to 14 inches in diameter. An auxiliary cutter spindle is also provided which is driven through hardened helical gears from the main spindle. This auxiliary spindle makes it possible to use



Gould & Eberhardt Automatic Gear-cutting Machine of Unusually Large Size

cutters of ordinary sizes, thus adapting the machine for cutting smaller gears. The use of these two spindles enables this machine to handle a great variety of sizes of gears ranging from small pinions up to the large size gears referred to in the preceding paragraph.

The machine is entirely automatic in operation and is equipped with many of the features of the Gould & Eberhardt gear-cutting machine of smaller size. A wide range of cutter speeds is provided and the cutter feeds, which are independent of the speeds, may be conveniently changed through an improved type of gear box. The indexing worm-wheel is of the split rim type and exceptional care has been taken to hob it accurately. The index and feed mechanisms are connected through a system of inter-locking levers which are so arranged that it is impossible for the feed clutches to be engaged until the indexing operation has been completed. A system of oil pans completely covers the worm-wheel and prevents oil from splashing onto the floor. An

oil pump of generous proportions supplies a liberal flow of cutting compound to the cutters.

In addition to being used in its regular capacity, the machine is so arranged that worm-wheels can be hobbed automatically without previously gashing the teeth. The cutter spindle is geared in unison with the indexing worm and single or multiple thread hobs may be used with equal facility. The speed of the indexing wheel may be varied to suit the different sizes of gears. The cutter spindle may be locked in any desired position for hobbing and an automatic mechanism gradually feeds the hob into the wheel. The weight of the machine is about 35,000 pounds.

MARTELL ALIGNING REAMER

A garage engaged in handling a general line of repair work finds that the bearings constitute the greatest element of uncertainty in making an estimate on the price to be charged for overhauling a car. This is due to the great variation in the amount of wear which may be found in the bearings of different cars. With the view of overcoming this difficulty, the Martell Motor Co., 1928 Columbus Ave., Boston, Mass., has brought out an aligning reamer which is shown in operation in Fig. 1. When this reamer is used, badly worn bearings may be refinished with practically the same rapidity as those which have very little wear so that the repair man is able to estimate intelligently on this part of the work.

The reamer shaft is supported by a number of temporary bearings which engage directly with the holes to be reamed, thus making the device entirely independent of the form of the supporting members of the bearings. The fact that it is not necessary to bolt the crank-case down rigidly is also a feature which adds to the assurance of perfect bearing alignment. The reamer shaft is easily adjusted in relation to any given points, as, for instance, paralleling a surface or providing for the proper mesh of gears. An ample range of adjustment of the reamer blades is also provided. The reamer heads are secured to the shaft in such a manner that they may be rigidly clamped to the shaft in any desired position.

An eccentric flanged bushing that is mounted directly on the reamer shaft has the flanged portion provided with a radial slot concentric to the surface engaging with the bore of a second bushing. This second bushing is also of the eccentric flanged type and is an easy fit over the first bushing. The flanged portion of the second bushing is provided with six tapped holes which are located on a circle that is concentric with the bore; and a cap-screw passing through the radial slot serves to lock the two bushings together in any desired position. The edges of the flanges of these bushings are graduated, one bushing having nineteen divisions and the other twenty, thus affording a vernier which shows the eccentricity of the two bushings in thousandths of an inch. The range of variation is from zero to 0.095 inch. A conical bushing with the taper portion threaded with seventy threads per inch is screwed firmly into the end of the bearing or hole to be reamed. The bore of this conical bushing is ground to receive the larger of the two bushings previously referred to and is provided with four clamping screws to lock the position of the bushing when the desired adjustment has been obtained.

It has already been mentioned that the reamer is equipped with two heads, each of which carries six blades which are assembled in suitable slots. There are wedges at each end of these slots which engage the inclined surfaces of the blades and allow them to be moved toward or away from the center through the action of adjusting nuts. The reamer heads are held in any desired position on the shaft by means of locking nuts. The reamer blades are oil tempered and ground and provided with a 6-degree angle on the cutting edge.

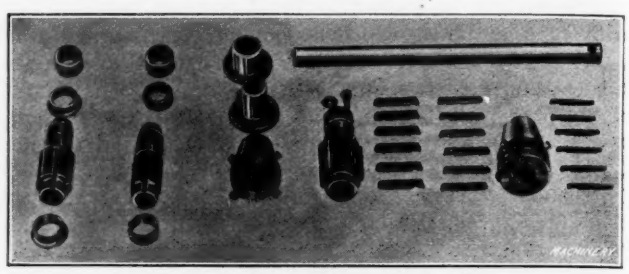


Fig. 2. Parts of the Martell Aligning Reamer

The reamer is shown in Fig. 1 refinishing the crankshaft bearings of a 1912 Packard six-cylinder motor. The crankshaft gear is mounted directly on the reamer shaft by means of a special bushing, and the proper mesh of the gears is obtained by means of eccentric bushings. The rear end of the shaft is next aligned to bring it parallel to the top of the crank-case. In order to ream all the way through the bearings, the bushings at the back end must be removed. The reamer blades are provided with a cutting edge on the front end only, and when the bushing is removed the reamer acts as its own guide for the short distance that remains to be reamed. After each bearing has been reamed the bushing that was removed for the purpose is replaced in its former position. In this manner the work is easily and accurately handled. This reamer was designed for reaming automobile crankshaft bearings, the idea being to provide the repair man with a means of accurately aligning such bearings and saving time in the operation. An idea of the rate at which the tool works may be gathered from the fact that the job shown in Fig. 1 was completed in eleven hours without any attempt having been made to establish a record.

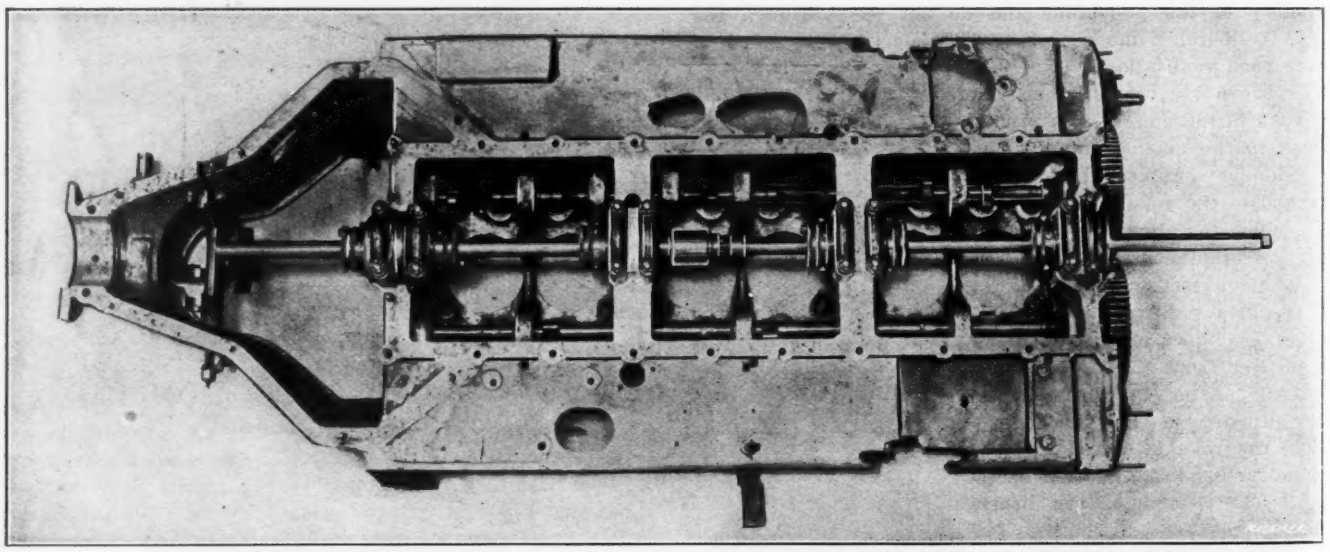


Fig. 1. Martell Aligning Reamer refinishing the Bearings of the Crank-case of a Packard 1912 Model Six-cylinder Motor

GARDNER MOTOR-DRIVEN POLISHING LATHES

The motor-driven polishing lathe shown in the accompanying illustration is a recent product of the Gardner Machine

Co., Beloit, Wis. The notable features of this machine are the application of motor drive, the motor starter and the way in which the spindle construction has been worked out. The fully enclosed direct-current motor is of the commutating pole type and runs without any sign of sparking. It has a continuous rating of 4 horsepower and a two-hour rating of 6 horsepower. The compound starter is mounted within the base of the machine and is accessible by opening the hinged door at the front. A speed variation of from 2000 to 3000 revolutions per minute may be obtained.

The spindle is of unusual size and mounted in ball bearings. In the No. 3 size machine shown in this connection, the spindle is 49 inches in length; its maximum diameter is 2¼ inches and the diameter between the flanges is 1¼ inch. The complete weight of the No. 3 machine is 850 pounds. The same type of machine is made in two smaller sizes, known as the No. 2 and No. 1 Gardner polishing lathes. The No. 2 machine has a spindle 42½ inches long, the diameter between the flanges being 1 inch; the No. 1 machine is equipped with a spindle 32 inches long and the diameter between the flanges is ¾ inch. The preceding spindle lengths

No. 3. Gardner Ball Bearing Motor-driven Polishing Lathe

are standard, but special spindles of different lengths may be supplied to meet the requirements of different classes of work.

DETROIT SEMI-AUTOMATIC DRILLING MACHINE

The semi-automatic horizontal drilling machines which form the subject of this article were designed by the Detroit Tool Co., Detroit, Mich., for drilling small holes in small work. Drilling of this nature requires precision, speed and rapid handling, and these machines meet the requirements in a very satisfactory manner. The horizontal spindles permit the work to be held in fixtures of simple design, in which the work can be located without moving the fixture or risking interference by the drill. Both the work and drill are constantly visible. The working parts are all enclosed, thus protecting both the mechanism and operator from injury. On most classes of work, the capacity is governed entirely by the speed with which the operator can handle the work. The drills are fed automatically by cams, and as the feeds are entirely independent of the operator, it is necessary for him to maintain a steady rate of production or fall behind the machine. These drilling machines are made in two sizes, known as the No. 1 and No. 2. The principal features of both machines are identical and the following description applies to either machine. The No. 1 machine is designed particularly for drilling very small work at high speed, while the No. 2 machine is adapted for handling work of a more general character, and to adapt it for this purpose it has a wider range.

As previously stated, the operator is merely required to look after placing the blanks in the work-holding fixtures

Fig. 1. Detroit Semi-automatic Horizontal Drilling Machine

and removing the finished product. The drills advance automatically at the proper rate of feed so that they enter the work without breaking. If desired, the cams may be so formed that the feed increases automatically after the drills have started, and when so desired the drills may also be backed out to clear the chips out of deep holes. When a hole is finished, the drill is withdrawn and remains back long enough for the finished piece to be removed from the fixture and a fresh blank mounted in its place. In the meantime, a steady flow of cutting lubricant has washed away

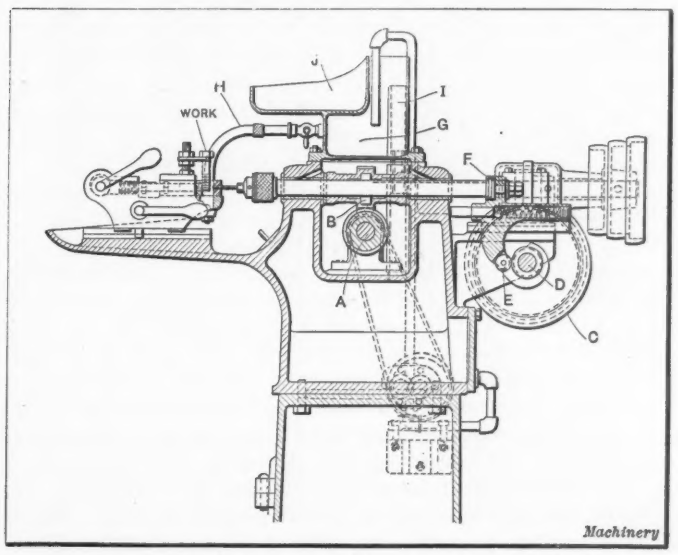


Fig. 2. Cross-section through Machine showing Feed Mechanism

the chips so that the work and fixture are clean. The cams for feeding each drill are so timed that the holes are drilled in rotation. In this way the operator is able to divide his time between the five work-holding fixtures, and by the time he has placed a blank in the fifth fixture, the hole has been finished in the piece held in the first fixture and he can go

back and replace this piece by a fresh blank. He then begins changing the finished product for fresh blanks in each fixture in turn, performing this cycle over and over. Fig. 2 shows a cross-sectional view of the machine, from which the design will be readily understood. The main driving shaft *A* extends through the bed at right angles to the spindles, which are driven from this shaft by means of spiral gears *B*. Between the first and second, and the fourth and fifth spindles and parallel to them, there are two shafts, one of which is driven by spiral gears from the main driving shaft *A* and the other connected to the cam-shaft *D* through a worm and gear *C*. These two shafts are connected at the rear of

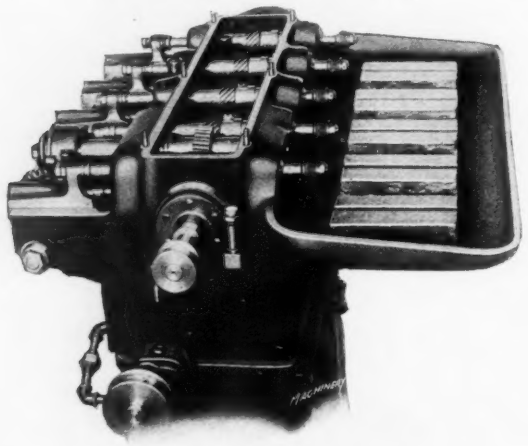


Fig. 3. Arrangement of Spiral Gears connecting Driving Shaft and Spindles

the machine by a belt running over three-step cone pulleys, thus providing three different spindle feeds for each spindle speed. The feed of the spindles is obtained by cams carried on the cam-shaft *D*, which operate against rollers *E* attached to slides carried on the rear end of the spindles. The cams force the spindles forward, thus feeding the drills into the work, and the spindles are withdrawn by springs.

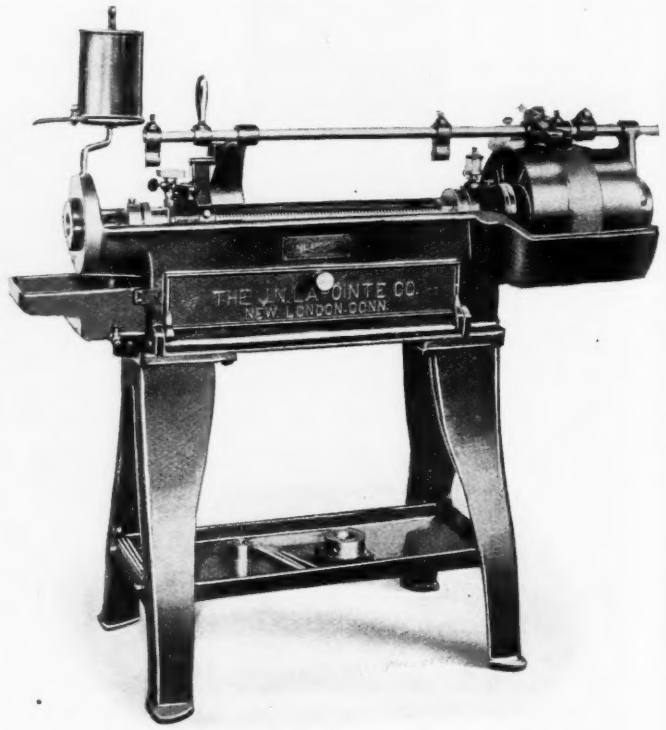
Spiral and worm gears are used throughout the machine. All of the gears are located in a compartment in the bed at the rear of the pan as shown in Fig. 3. The construction forms an oil-tight compartment which completely encloses the gears, and when supplied with oil constitutes a self-oiling system. Both the gears and the spindle bearings and main shaft bearings are lubricated from this source. The spindles are made of hardened alloy steel, and are ground to the required finish and carefully balanced. On the No. 1 machines the spindles are ¾ inch in diameter, and have a taper of 0.9 inch per foot to fit a standard No. 1 chuck. On the No. 2 machine, the spindles are 1 inch in diameter, and have a taper of 0.96 inch per foot to fit a standard No. 2 chuck. On both machines, the end-thrust of the spindles is taken on ball bearings at the rear, which are shown at *F* in Fig. 2. Each spindle is carried in two bearings of ample size, which are lined with bronze. The main driving shaft bearings and the bearings of the two shafts controlling the cam-shaft are also bronze bushed. All of the bearings are line reamed.

Cutting lubricant is supplied to the drills from the tank *G*, from which it is conveyed by curved pipes *H*. A uniform flow at a constant pressure is insured as the surplus oil is pumped into the upper tank where a uniform level is maintained by means of the overflow *I*. The oil is drained from the chip pan through a strainer into a settling pan in the base of the machine. From there it passes to a reservoir in the base, from which it is pumped back to the upper tank *G*.

The saving of drills effected by the automatic feed employed on this machine is an important feature. Where drills are fed by hand, the rate of feed and strain on the tool varies considerably and results in a serious breakage of drills. With the cam mechanism employed on the Detroit drilling machines, however, the most suitable feed may be determined and this feed constantly employed. Where the drill enters a piece at an angle, or where other conditions exist which make it difficult to start the hole, the feed cams may be so shaped that the feed is slow at the start and accelerates automatically after the drill has entered the work. On deep holes it is frequently good practice to form the cams in such a way that the drills are withdrawn after the hole has been drilled to about one-half the required depth, thus clearing the chips from the hole. The machine is of compact design, and this feature, together with its high rate of production, means a considerable saving of floor space, which is at a decided premium in many factories. This feature is further enhanced by having a work-pan shown at *J* in Fig. 2 provided at the top of the machine. This does away with the necessity of using a table or some other space consuming equipment to hold the supply of work.

J. N. LAPOINTE NO. 0 BROACHING MACHINE

The broaching machine, illustrated herewith, was designed by the J. N. Lapointe Co., New London, Conn., to meet the requirements of a manufacturer who had work to be broached that was too small to be handled conveniently on a larger sized broaching machine. The machine proved so successful in operation that it is now being built for the market. The driving mechanism is of the simple planer type used on other J. N. Lapointe broaching machines and an automatic brake is provided. A belt shifting rod is located at the top of the machine which extends for its entire length. The automatic adjustable stop dogs are mounted on this rod and they may be set at any desired position according to the length of the broach that is to be used. A handle is also mounted on this rod which provides for operating the shifting mechanism by hand. This feature is particularly convenient in allowing the machine to be stopped instantly—regardless of the position of the automatic stops—in case the broaching tool fails to operate satisfactorily. The sliding head is arranged with vertical adjustment to provide



J. N. Lapointe No. 0 Broaching Machine for Small Sized Work

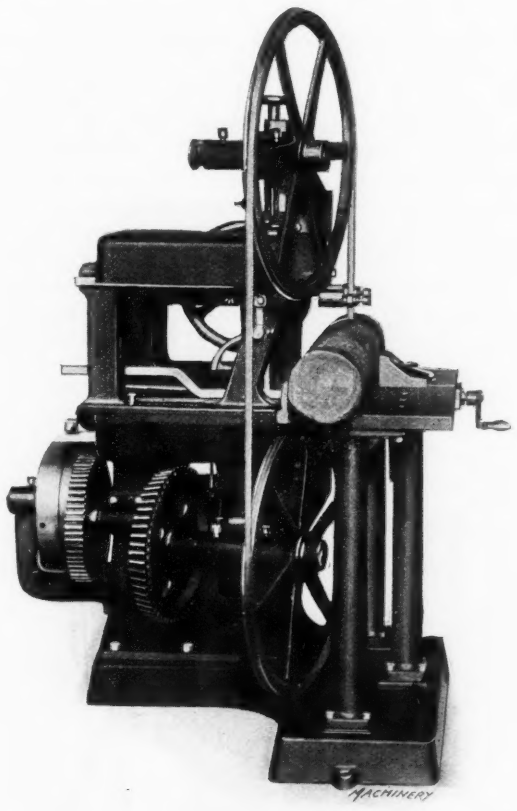
for regulating the position of the broaching tool to the desired height.

An oil pot at the top of the machine supplies lubricant to the broach and an oil pan is provided to catch the lubricant. This pan is detachable, permitting it to be removed and emptied when necessary. A small cupboard of sufficient length to hold the broaching tools when not in use is provided. The machine is made with legs and a pan as shown in the illustration; or it may be used without legs, in which case it is set up on a bench. The principal dimensions are as follows: Length of stroke, 21 inches; diameter of driving pulley on machine, 10 inches; width of driving belt, 1½ inch; width of return belt, 1 inch; weight of machine with legs, 445 pounds and without legs, 325 pounds. The capacity

of the machine is for cutting a keyway up to ¼ inch wide and of any reasonable length; holes up to ½ inch square by 1 inch long may be broached.

HOUGHTON & RICHARDS METAL CUTTING BAND SAW

In the August, 1913, number of MACHINERY, the drop-arm type of metal cutting band saw built by Houghton & Richards, 1394 W. 3rd St., Cleveland, Ohio, was illustrated and described. Since that time, the company has developed a straight-line metal cutting machine which is illustrated herewith. This machine is designed to cut to any required depth



Houghton & Richards Metal Cutting Band Saw

in irregular sections of all kinds, such as bar stock, piping, beams, etc.; in fact, any shaped wooden piece that can be cut on an ordinary wood band saw can be cut in metal on this machine. The construction is exceptionally heavy, and an automatic stopping device is provided in conjunction with an adjustable stop for regulating the depth of cut from zero to 6 inches. The feed is controlled by a weight located inside the standard which carries the sliding carriage. This weight is entirely covered but is easily accessible and provides a constant pressure of the saw against the work. The arrangement of the weight and cable is in the form of a Chinese windlass.

The sliding carriage which carries the wheels over which the band saw runs has large bearing surfaces with V-slides on the bottom and flat slides on the top. The adjustable stop is regulated by means of a small lever at the side of the sliding carriage; this lever is connected with a radius rod which slides the square rod that carries the stop either in or out, traveling with the carriage and controlling the depth of cut. When the small lever is set for any required depth of cut and the sliding carriage has traveled the required distance, the stop on the square bar comes into contact with the lever which holds the belt shifter on the tight pulley. The engagement of the stop and lever causes the shifter to be released and a spiral spring then throws the shifter over, moving the belt onto the loose pulley and stopping the machine. The sliding carriage is returned by means of a handwheel which is connected with a small steel pinion and steel rack on the sliding carriage. The carriage is held in place by a self-acting lock which must be released by hand before it can advance for another cut.

The guide rollers are of tool steel, hardened and ground, and hold the band saw in line for making the cut. An adjustment for alignment of the band wheels is furnished on the upper arm at the tension side of the saw and when once set, the wheels are set for all bands. The band saw used on the machine is ⅝ inch wide by 0.0312 inch thick, and for the machine having a capacity for cutting work up to 6 inches in diameter the saw is 12 feet 6 inches long. The heavy construction adapts the machine for standing up under hard usage. The illustration shows a machine equipped for belt drive, but if so desired, motor drive through a silent chain or direct gearing may be employed. An idea of the capacity may be gathered from the fact that the time required to cut through a 6-inch bar of tungsten steel is about 24 minutes and the disk will be within 0.004 inch of parallel. Operating at this rate, the capacity of a band saw will be to cut from 1200 to 1500 square inches of steel, depending on the speed and the material. The floor space occupied by the machine is about 9½ square feet.

Since the preceding type of drop-arm band saw built by Houghton & Richards was described in MACHINERY a number of important improvements have been made, among which the following may be mentioned: A positive worm geared feed has been provided for use when the saw is engaged in cutting work of large diameter. This mechanism applies exactly the same pressure on the saw all the way through the cut and adds to the life of the blade on this account. The friction feed can be used on work up to 3 inches in

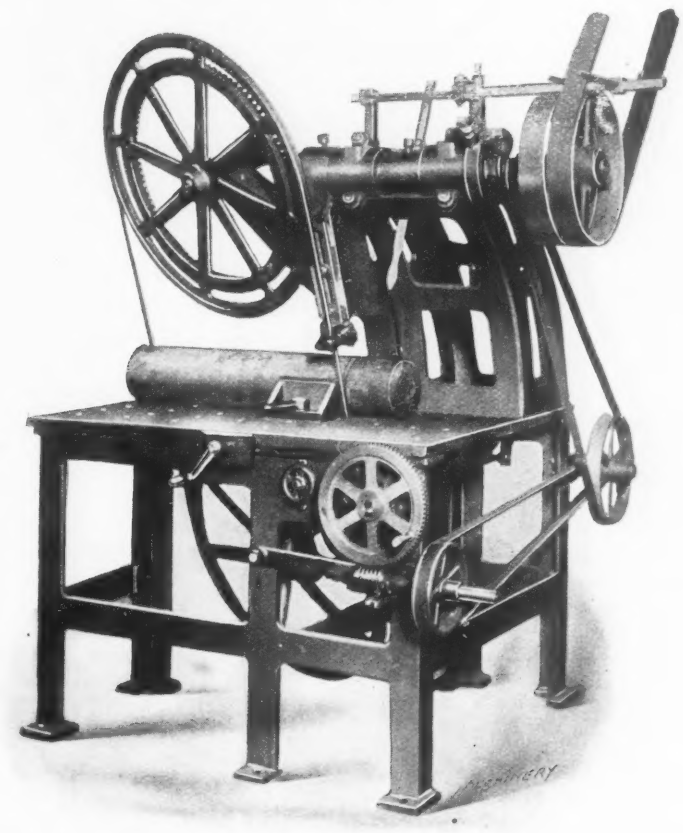


Fig. 2. Improved Type of Houghton & Richards Drop-arm Saw

diameter but the use of the positive feed mechanism for all sizes of work is recommended. When the positive feed is used the machine requires absolutely no attention after it has been started. Using the friction feed, it is possible to cut a 3-inch bar in seven minutes, but operating at such a speed the life of the band saw blade is relatively short. When the positive feed is used, the life of the saw is considerably increased, as the pressure on the saw is constant. A band saw blade ⅝ inch wide by 0.031 inch thick will cut from 1000 to 1500 square inches of steel when running at a speed of 135 feet per minute. This improved drop-arm saw has a capacity for cutting stock from zero to 8 inches in diameter

and it will cut off 8-inch tungsten or carbon steel disks so that the two faces will not be more than 0.002 inch out of parallel.

CORBIN SAFEGUARD FOR PRESSES AND DROP HAMMERS

The Corbin Cabinet Lock Co., New Britain, Conn., is now manufacturing a safeguard to protect the operators of power presses and drop hammers from injury. A power press equipped with one of these guards is illustrated in Fig. 1, and Fig. 2 shows one of the guards in place on the drop hammer. The number of accidents which occur to the operators of power presses and similar machines has led to the development of a great variety of safeguards to provide for the safety of the operators of such machines. In a great many cases, however, these guards have proved inefficient because they hinder the operator in the performance of his work.

The important feature of the Corbin safeguard is that the view of the work is unobstructed at all times and the guard

Fig. 1. Power Press equipped with Corbin Safeguard

affords adequate protection to the operator without hindering his work in any way. The principle on which this guard operates can best be explained by referring to Fig. 1. It will be seen that a bracket is attached to the frame of the press, from which a horizontal bamboo stick is suspended in such a way that it is free to swing. This stick rests against the operator's arms at a point a little above the elbows. When he reaches forward to adjust a piece of work in the die, the stick is pushed forward. A thin metal rod is attached to one end of the bamboo stick, and when the stick is pushed forward this rod slides a stop into place, which locks the treadle rod in such a way that it is impossible to trip the press. When the operator has adjusted the work and draws his hands back from the die, the bamboo stick drops back to its former position and the stop is drawn back so that the press can be tripped. From this description it will be evident that the operator is not required to pay any attention to the safeguard, and it works so smoothly that he is not conscious of it. Consequently, it does not reduce his efficiency in any way.

LANGELIER SEMI-AUTOMATIC TAPPING MACHINE

The accompanying illustration shows a vertical semi-automatic multiple spindle tapping machine equipped with a stationary head and movable work table which is built by the Langelier Mfg. Co., Providence, R. I. This machine is designed to tap a large number of holes in a single operation and in practically the same time that it would ordinarily take to tap one hole with a single spindle tapping machine. With the new Langelier machine, the duties of the operator are reduced to merely placing the blanks on a simple work-holding fixture and taking off the tapped parts. The cycle of operations is so rapid and exact that as many as fourteen brass plates 1/16 inch in thickness, with seven holes tapped in each plate, have been turned out by this machine in a minute. The machine is especially adapted for use in plants making large quantities of similar parts—such as factories engaged in the manufacture of automobile parts, clocks, typewriters, electrical instruments, camera shutters, telephones and a great variety of other products.

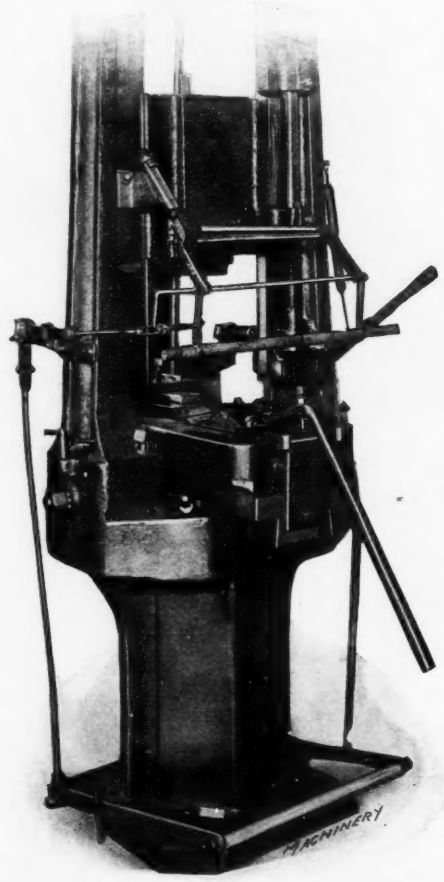


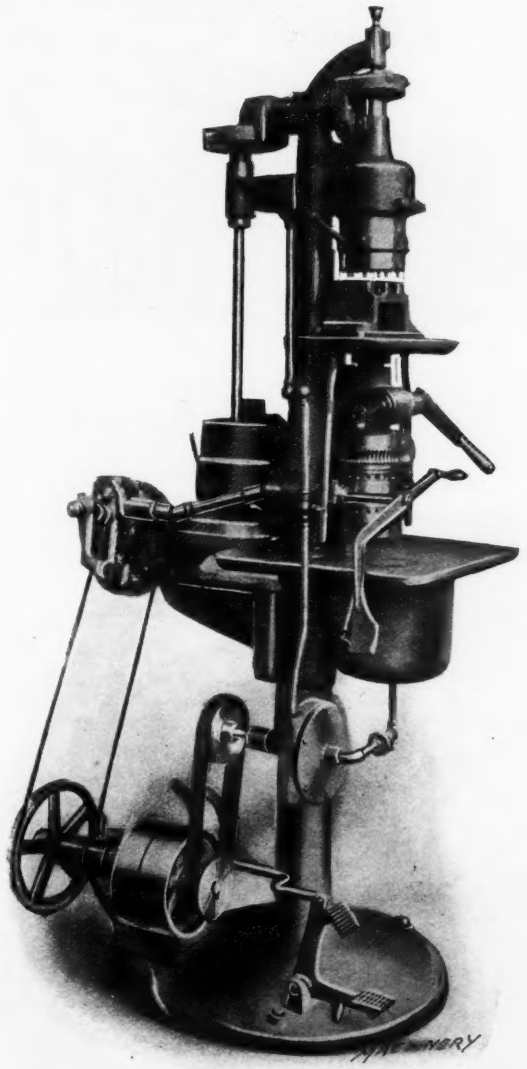
Fig. 2. Corbin Safeguard in Place on a Drop Hammer

The operator starts the machine by tripping a knee lever or by lowering the opposite end of this lever by hand. This operates the belt shipper and moves the belt to the forward driving pulley. In so doing, an upright shaft whose main function is to drive the main spindle of the multiple tapping head is set in operation, thus starting the multiple spindle tapping head. The tapping spindles in this head are crank driven; they are machined from steel bars, heat-treated and carefully finished by grinding. All of the spindles are accurately located on fixed centers and run in phosphor-bronze bearings. The head can be quickly removed from the machine to provide for the substitution of another head having a different spindle layout. In this way various parts can be tapped with the same machine by using different tapping heads interchangeably.

The spindles can be arranged in practically any desired way over a circle 5 inches in diameter. Each spindle is provided with a special compensating arrangement which permits the tap to follow its own lead independently of the way in which other taps are working. This insures having

every hole tapped with clean cut threads. It also makes it possible to operate taps with different pitches simultaneously and insures uniform and truly interchangeable work. On reaching the desired depth, the taps are reversed automatically.

The upright shaft which drives the multiple tapping head also drives a short horizontal shaft at the right of the machine, power for this purpose being transmitted through steel and bronze spiral gears. A steel worm is mounted at the front end of this horizontal shaft which meshes with a worm thread cut in a vertical hub under the work table. This hub has an edge cam path cut on its upper end, and a cam roller which is trunnioned to the stub post of the work table runs over this path when the hub is rotated by the worm on the horizontal shaft. During the tapping operation, the work table is raised by this cam and roller until the taps have penetrated to the desired depth. An automatic trip then operates, shifting the driving belt over to the reversing pulley, reversing the taps and lowering the table at almost double the speed at which the tapping operation was conducted. When the table reaches its lowest position, the trip again shifts the driving belt to the loose pulley and the machine stops, ready for the finished work to be removed and blanks substituted in its place. This cycle of operations is repeated with great precision and rapidity. The automatic stop may be set to stop the table at practically any desired point and the forward and reverse speeds may be closely adjusted to suit the conditions of different classes of work.

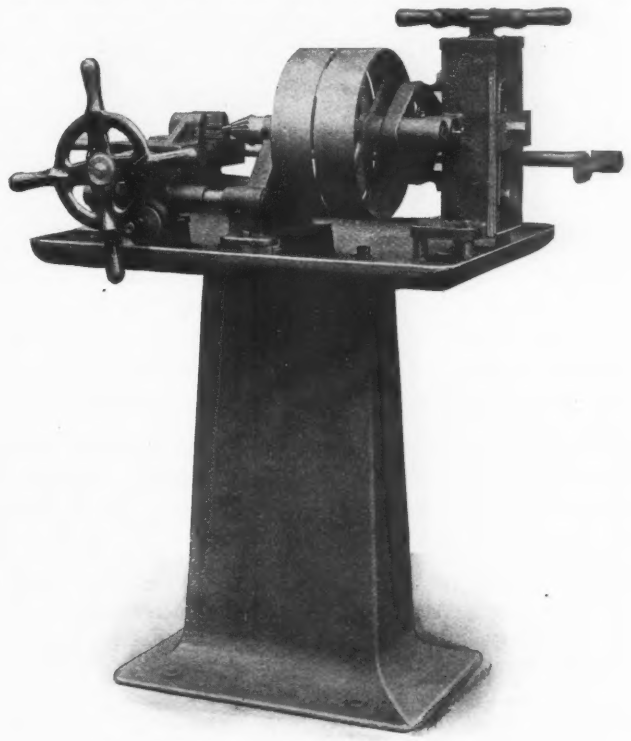


Langelier Semi-automatic Multiple Spindle Tapping Machine

The base of the machine carries tight and loose pulleys 6½ inches in diameter which carry a 2-inch driving belt. An automatic oil feed maintains a constant flow of oil on the taps while the machine is running and returns this oil to a self-straining reservoir connected to the pump suction. This enables the same oil to be used over and over without waste and without much attention from the operator. The oil feed operates intermittently, *i. e.*, when the machine stops, the flow of oil also stops automatically, thus preventing flooding the work and fixtures. All running bearings and movable parts are lubricated by means of efficient oilers.

OSTER CUTTING-OFF AND REAMING MACHINE

The machine for cutting off and reaming pipe and tubing which is illustrated herewith has recently been placed on the market by the Oster Mfg. Co., 2107 E. 61st St., Cleveland, Ohio. This machine represents the outcome of an order for a special machine of this type which was received by the



Oster Machine for cutting off and reaming Pipe

Oster Mfg. Co. some three years ago. The machine proved so satisfactory in operation that it was decided to build machines of the same type for the market. The capacity is for all sizes of pipe up to 2 inches in diameter.

The machine is equipped with a single wheel tube cutter. The pipe to be cut off rests on a pair of rollers, and by turning the handwheel at the top of the machine, the pipe is brought in contact with the cutting disk and quickly severed. A slight pressure on the wheel regulates the speed at which the cutting operation proceeds. The two rollers which support the pipe while it is being cut off are made of steel and revolve in steel bearings. These rollers rest on the bottom of a yoke which slides up and down in the frame. An adjustable gage provides for cutting off duplicate pieces of pipe of various lengths.

The pipe to be reamed is held in the vise jaws which are opened or closed by the handwheel at the front of the machine. The method of control is rapid, so that work can be handled in an efficient manner. The work is fed to the reamer by operating a lever mounted behind the wheel which controls the movement of the vise jaws, this lever causing the pipe to move back or forth as desired. The reamer is held stationary by a set-screw and can be readily removed for sharpening. The bearings of the machine are provided with oil cups which insures efficient lubrication. The range of the machine is for pipe from ¼ to 2 inches inside diameter. The floor space occupied is 24 by 16 inches, and the weight of the machine 510 pounds.

WISCONSIN PORTABLE ELECTRIC GRINDER

The "Dumore" portable electric grinder was designed by Mr. Chester H. Beach, engineer of the Wisconsin Electric Co., Racine, Wis., by which firm the tool is manufactured.

This grinder operates at high efficiency, and when extreme accuracy is desired it is found to give excellent satisfaction. The armature is dynamically balanced, thus insuring satisfactory operation at all speeds and eliminating chatter; what

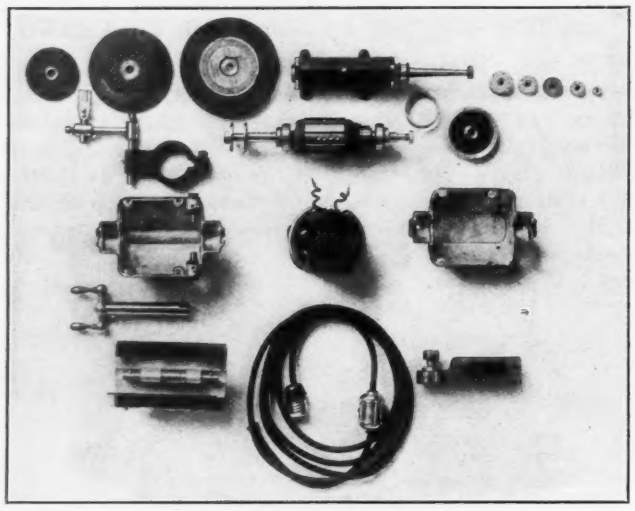


Fig. 1. Parts of the Wisconsin "Dumore" Grinder

is known as the "critical speed" is also avoided. The tool is suitable for handling a great variety of work, such as grinding milling cutters, taper reamers, lathe centers and dies and tools of different kinds.

The tool is of rigid construction and ball bearings are used throughout. The motor casings and internal housings are die-castings. The main shaft or spindle and also the spindle of the internal attachment are ground to within 0.00025 inch and carefully balanced. The motor, which is of the universal type manufactured by the Wisconsin Electric Co., develops ¼ horsepower. Wheels 4½ inches in diameter may be driven at 10,000 revolutions per minute which provides a suitable surface speed, and the internal attachment may be driven at

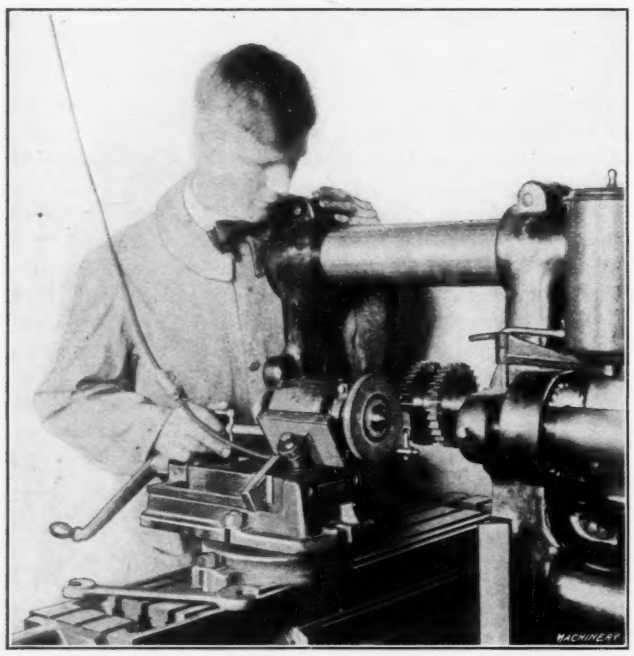


Fig. 2. Sharpening Milling Cutters with the Wisconsin Grinder

speeds up to 35,000 revolutions per minute to obtain the required cutting speed with the smallest wheel used on the grinder.

The parts of the grinder are illustrated in Fig. 1, from which the extreme simplicity and small number of parts will be appreciated. Referring to this illustration, the method of mounting the armature spindle in ball bearings will be readily understood. A complete set of wheels ranging in size from 4½ inches to ⅜ inch in diameter forms part of the regular equipment of the tool; these wheels will be seen at the top of Fig. 1. The total weight of the grinder is only sixteen pounds.

Fig. 2 shows the grinder employed in sharpening a pair of cutters on a milling machine arbor without requiring them to be removed. For this purpose, a rest is provided for supporting the cutters and the feed-screw of the grinder enables the wheel to be traversed back and forth. This feed-screw is also useful for grinding operations on a lathe which is not provided with a compound rest. Either angular, straight or spiral milling cutters may be ground and the elimination of the necessity of removing them from the arbor means a material saving of time.

In Fig. 3 the "Dumore" grinder is shown grinding a piece of work between centers. In Fig. 4 the internal attachment

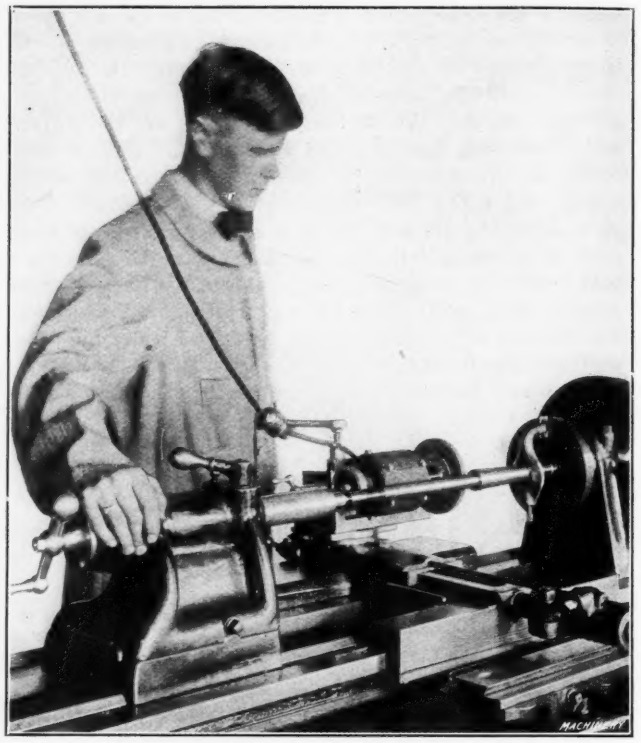


Fig. 3. Grinding Work on Centers with the Wisconsin Grinder

is shown in use. The work shown in this illustration is hardened and has an elongated slot and also a small hole, which are to be finished by grinding. Such work is easily handled by this portable electric tool. The preceding illus-

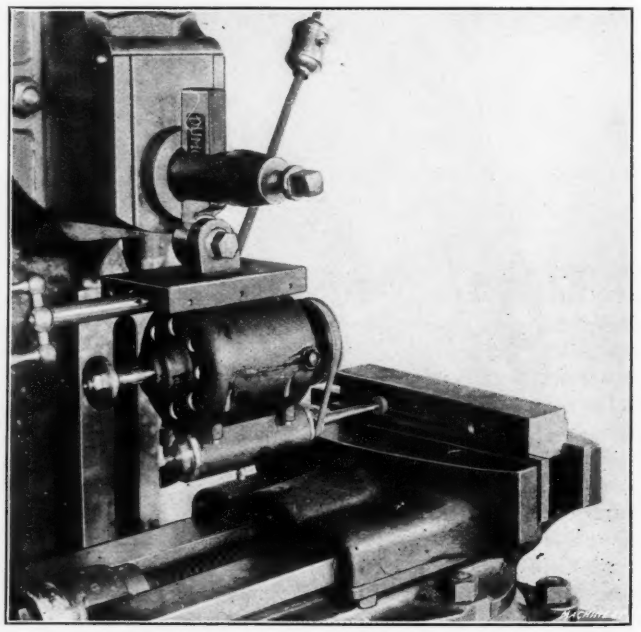


Fig. 4. Application of the Internal Attachment of the Wisconsin Grinder

trations are merely indicative of the classes of work which may be handled, and they will suggest to any practical mechanic a great variety of operations which could be handled to equal advantage.

NIAGARA SIDE SEAMING MACHINE

Fig. 1 shows a side seaming machine which constitutes a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. This machine is intended for use in forming the longitudinal seam in sheet metal used in the manufacture of oil and asphalt barrels, ash cans and similar products. Fig. 2 shows in diagrammatical form the ends of two pieces of sheet metal before and after making the lock seam. This

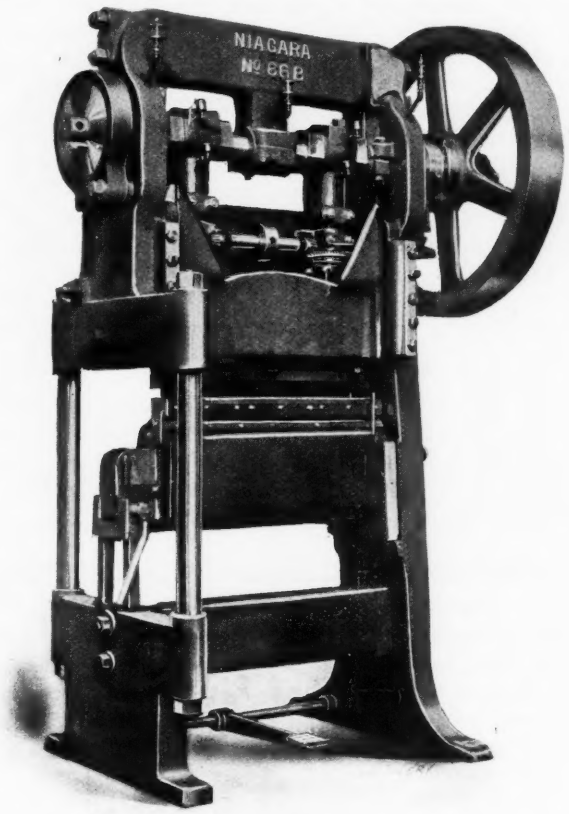


Fig. 1. Niagara Side Seaming Machine

seam is formed by two consecutive strokes of the machine. Aside from forming the body, no preliminary work is required. The motion of the machine is controlled by a positive clutch, and the horn has a swinging support on its outer end to provide for entering and removing the work. A safety lock is provided which makes it impossible to trip the clutch before the horn support is in the proper position. This machine has a capacity for work ranging from 9 to 24 inches in diameter, and up to 36 inches in length. Sheet metal up to No. 24 gage can be handled.

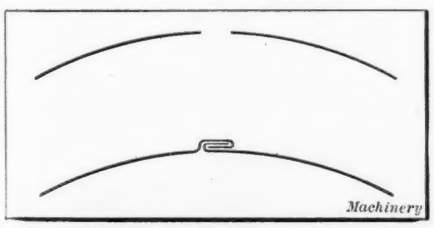
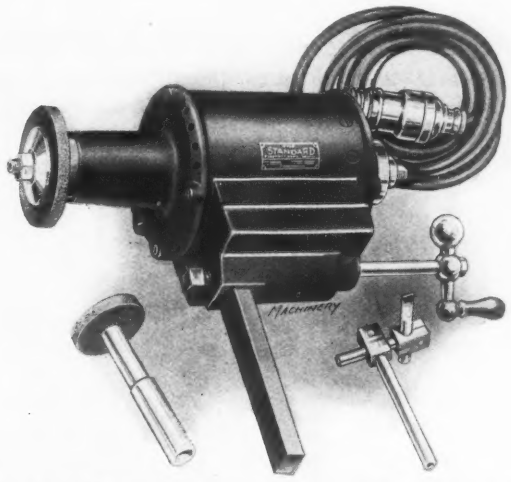


Fig. 2. Diagram showing Ends of Work before and after the Seaming Operation

STANDARD UNIVERSAL ELECTRIC GRINDER

The Standard Electric Tool Co., Cincinnati, Ohio, is now making a line of portable electric toolpost grinders equipped with universal motors. These motors are designed to operate on either direct current or alternating current of zero to 60 cycles, although they are particularly adapted for 25-, 30- or 40-cycle circuits. The spindle runs in ball bearings which are enclosed in dust-proof cases and packed with grease. This arrangement eliminates the necessity of oiling and prevents damaging the motor windings with thin oil used to lubricate the bearings. These grinders are made with either 1/6- or 1/4-horsepower motors and run at a speed of approximately 6000 revolutions per minute, which makes them effective for internal grinding.

The Standard Electric Tool Co. has also added to its line of universal drills two tools of ⅝ and 1 inch capacity, respectively. These two drills constitute an addition to the seven sizes of the same type of tool which have been on the market for some time. The motors of both the grinders and drills are form wound and impregnated with bakelite which is known to be very effective in preventing short circuits and other trouble incident to the operation of motors at high

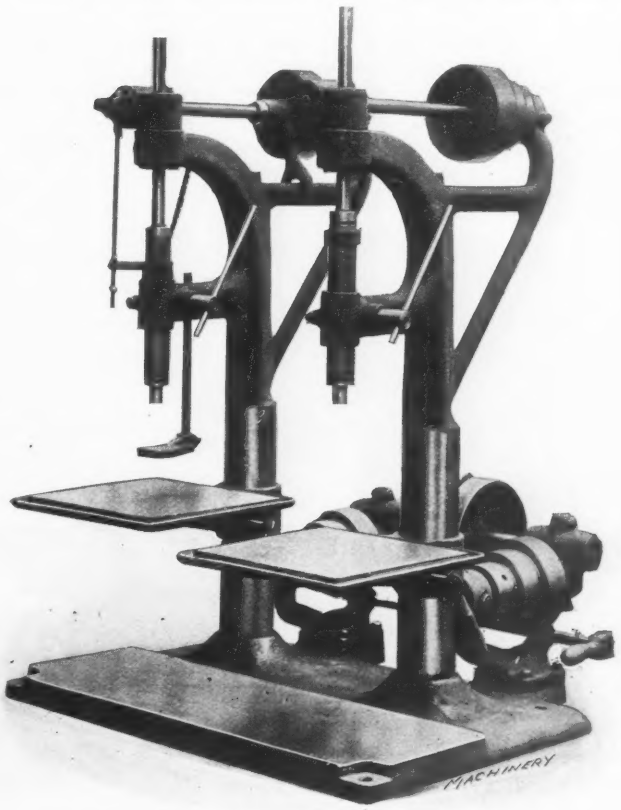


Standard Electric Grinder for Use on either Alternating or Direct Current Circuit

speed. The motors are air cooled by means of a fan, and are capable of being severely overloaded without damage. The design is simple and rigid, although particular care has been taken to keep the weight down as far as possible. The tools are built on the unit plan so that they are easily taken apart.

PIONEER DUPLEX DRILLING AND TAPPING MACHINE

A 12-inch combination drilling and tapping machine built to meet modern manufacturing requirements has recently



Pioneer 12-inch Duplex Drilling and Tapping Machine

been added to the line of the Pioneer Machine Co., Rockford, Ill. The right-hand spindle of this machine is used for drilling and the left-hand spindle for tapping, but the tapping

spindle can also be used for drilling or reaming operations by raising the sliding rod in front of the machine to its highest position and taking off the lower dog on the rod. Referring to the illustration, it will be seen that the front part of the base is planed to form an auxiliary table for use in handling work for which the regular table of the machine is inadequate. The capacity of the machine is for drilling holes up to ½ inch in diameter and for tapping holes up to ⅜ inch in diameter.

NEWTON DIE-SINKING MACHINE

The Newton die-sinking machine illustrated in this connection was particularly designed for machining large metal molds, and the control is so flexible that cutters as small as

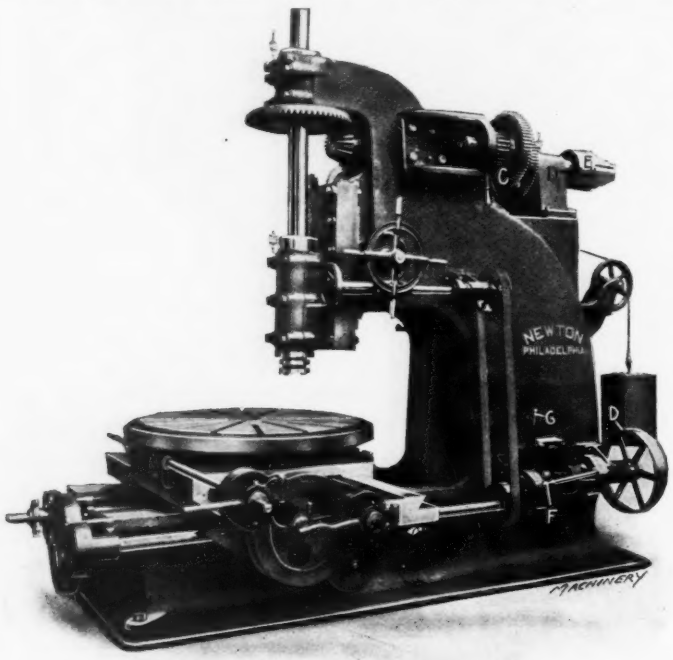


Fig. 1. Operating Side of Newton Die-sinking Machine

¼ inch in diameter may be used. These cutters are several inches in length and tapered to machine the "drag" in the mold. The machine is driven by an alternating-current motor, the pad for the motor being shown at *A* in Fig. 2. Changes of speed are provided by gears in the oil-tight case *B*, in which there are eight gears which provide six changes of speed. In addition to these changes, reductions of speed for driving cutters of large diameter are obtained through the back gears shown at *C* in Fig. 1.

Reversing feed and reversing fast power traverse are provided in addition to hand adjustment, and each movement is independently clutched. The motion for the fast power traverse is transmitted from the pulley *D* at the base of the machine in Fig. 1 to the pulley D_1, and the motion for the feed is from the cone pulley *E* to the cone E_1. The lever *F* controls the engagement of the fast power traverse and feed, and the lever *G* controls the direction of traverse and rotation. As the same mechanism provides vertical feed and fast power traverse to the counterweighted spindle saddle, the control is centralized. Movement of the spindle saddle by hand is also available.

This machine was recently built for export, and as it is intended for producing work dimensioned according to the metric system, special indexes were mounted on the feed-screws. In view of the fact that an ordinary die-sinking machine weighs about 6000 pounds, while the present machine has a weight of 30,000 pounds, the accuracy with which it operates is really remarkable. The principal dimensions are as follows: diameter of the spindle, 5 inches; diameter of working surface of table, 48 inches; cross-feed of table, 72 inches; in and out feed, 62 inches; height from center of table to under side of spindle, 22 inches; and distance from center of spindle to face of upright, 38 inches. This machine is a product of the Newton Machine Tool Works, Inc., Philadelphia, Pa.

PIONEER DRILLING AND TAPPING MACHINE

The accompanying illustration shows a 12-inch combination drilling and tapping machine which has been recently brought out by the Pioneer Machine Co., Rockford, Ill. Referring to the illustration, it will be seen that the machine is equipped with a foot treadle for operating the spindle, which leaves both of the operator's hands free to handle the work. The spindle is driven by a pair of spiral gears running in grease and all bearings are equipped with ring oilers. These machines are also built with hand lever feed.

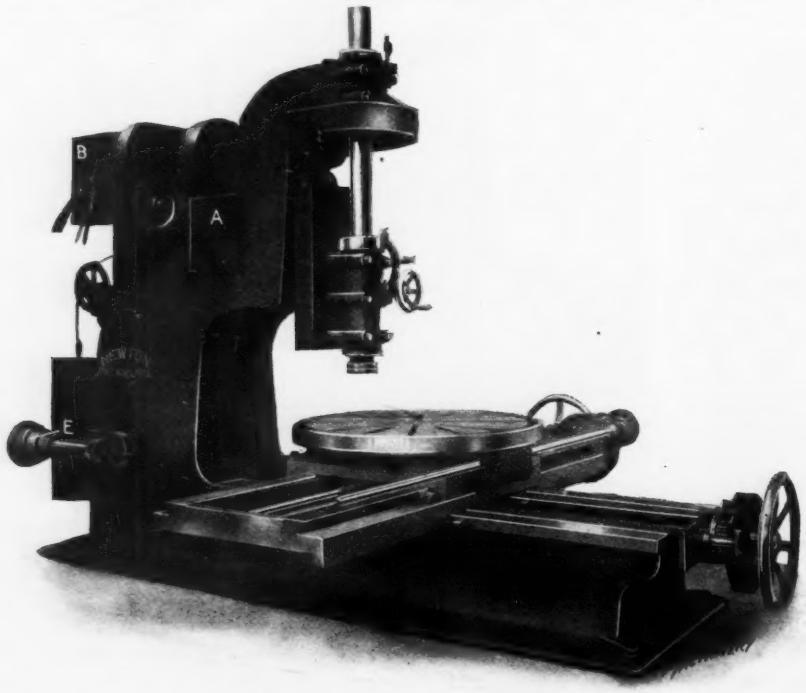
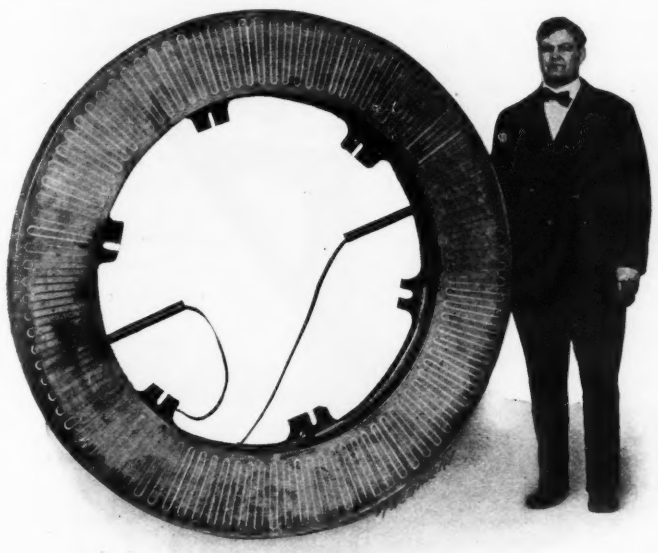


Fig. 2. Left-hand Side of Newton Die-sinking Machine

Pioneer Combination Drilling and Tapping Machine

WALKER MAGNETIC CHUCK

O. S. Walker & Co., Worcester, Mass., have just completed what is said to be the largest rotary magnetic chuck ever built. It is 70 inches in diameter (see illustration) and weighs 2400 pounds. It will be seen that the magnetic face of the chuck is ring-shaped; the width of the face is 11 inches and the chuck is 5½ inches thick. It will be used for holding a large quantity of three-inch washers while



Walker Rotary Magnetic Chuck 70 Inches in Diameter

grinding them and the chuck is designed to be used with water. It will be mounted on a special grinding machine and rotated in a horizontal plane; two grinding wheels will do the facing.

A general idea of the size of the chuck will be obtained from the illustration. Two hundred and fifty pounds of magnet wire was required for the coils, and there are ninety-six separate poles in the chuck and forty-eight magnetizing coils. As previously stated, the diameter of the chuck is 70 inches; before building this chuck, O. S. Walker & Co. have seldom had a call for rotary chucks larger than from 38 to 44 inches in diameter. The magnetic face of the chuck is very finely divided so that small work may be firmly held on it. The chuck requires 5500 watts to energize it, *i. e.*, 50 amperes at 110 volts. The face of the chuck can be instantly demagnetized by operating a special switch provided for that purpose.

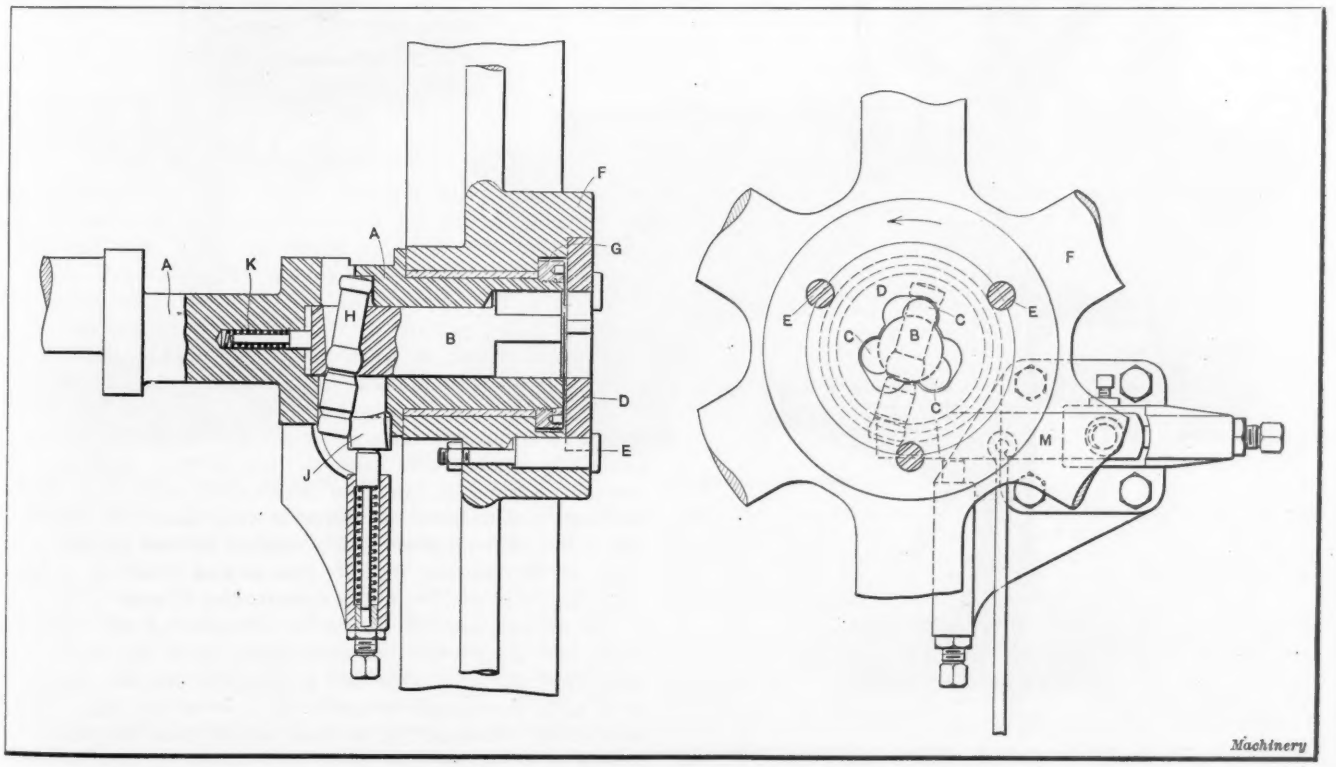
The firm for which this chuck was built intends to feed the work to the chuck through a chute and after grinding the work, it will be swept off while the chuck is rotating.

MAX AMS POWER PRESS CLUTCH

The Max Ams Machine Co., Mount Vernon, N. Y., has brought out a positive type of clutch for use on power presses, and this clutch will be applied on nearly all of the machines built by this company. A cross-sectional and an end view of the clutch are shown, from which the design and method of operation will be readily understood. Referring to this illustration, *A* is an enlargement of the press shaft; *B* is a sliding key or locking pin which has two or more prongs *C* formed on it; and *D* is a hardened plate with an opening in the center which is formed with notches to receive the prongs on the locking pin *B*. Two or more bolts *E* are used to secure the plate *D* to the flywheel *F*. The flywheel runs continuously on the shaft *A* and is held by a nut *G*.

The locking pin *B* is operated by means of the rolling lever *H* and the wedge *J*. The clutch is operated in the usual way. The wedge *J* is connected with the treadle rod and when the treadle is depressed, the spring *K* forces the locking pin *B* into the notched plate *D*, thereby forming connection between the shaft and flywheel. After one revolution of the shaft, the wedge *J* acts upon the lever *H*, withdrawing the locking pin *B* and disconnecting the flywheel from the shaft.

The distinctive features of this clutch are its durability and simplicity. The flywheel is centrally gripped on two or more points, thus avoiding irregular wear in the flywheel bearing. The striking surfaces are as near to the center of the shaft as possible, thereby reducing the velocity to a minimum and avoiding a hard blow; they are of ample size and located at the end of the shaft, where they are easily inspected. The parts subject to wear can be removed quickly and easily without interfering with the flywheel or any other parts. The locking pin *B* can be removed in an instant by simply pushing it against the spring *K* so that the rolling lever *H* can be pushed out sideways, thereby leaving the locking pin free. The steel plate *D* can be removed by simply taking out the bolts *E;* this enables the plate to be



Cross-sectional and End Views of Max Ams Power Press Clutch

reversed when one side has become worn. The wedge *J* is cushioned in order to avoid clicking. It is made with a shoulder which prevents the press from making a second stroke unless the treadle is completely depressed. This wedge is mounted on a separate bracket. Proper oiling devices are provided and a positive stop adjustment can easily be applied, thus making it necessary for the operator to depress the treadle for each stroke of the press.

KOKOMO "HI-SPEED" DRILL

The Kokomo "Hi-speed" drill equipped with power feed and an automatic stop is shown in Figs. 1 and 2, and Fig. 3 shows the same style of machine equipped with hand feed and a friction tapping attachment. It will be seen that these machines are of the sliding head type and they are suitable for driving high-speed drills up to ¾ inch and taps up to ½ inch. Removable bronze bushings are provided throughout the machines, which not only insure high efficiency, but also provide perfect alignment and long life. Another advantage of the bronze bushings is that they can be renewed when worn out or damaged without disturbing the alignment of the machine, it being merely necessary to take out the damaged bushing and insert a new one in its place. This can be done with little loss of time.

The tapping attachment shown on the machine in Fig. 3 is easily operated and enables the reverse to be made very quickly. A friction is mounted in the crown gear which gives the forward drive for the tap; and a similar friction mounted in the reverse pulley provides for backing out the tap. A clutch mechanism is located between these frictions,

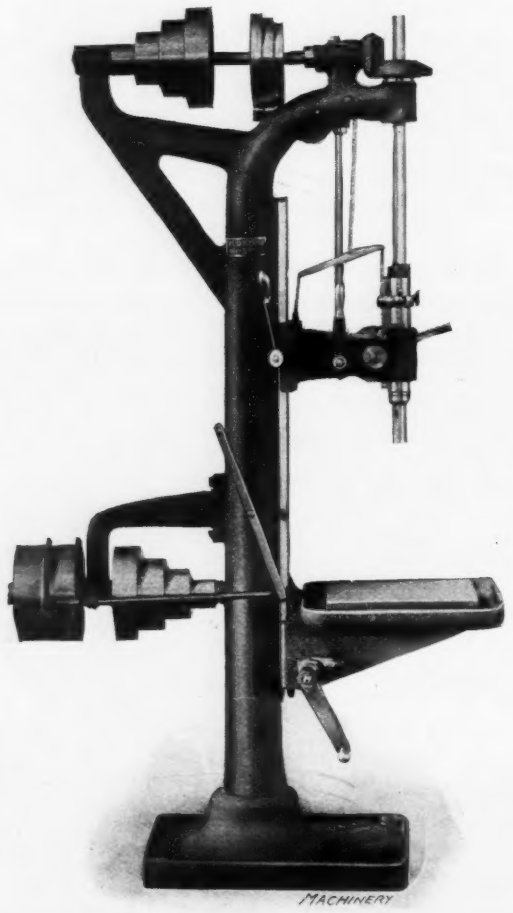


Fig. 1. Kokomo "Hi-speed" Drill equipped with Power Feed

the clutch being operated by a lever by means of which forward or reverse movement of the tap may be obtained, or the lever may be brought to a neutral position to stop the spindle. An important feature of the attachment is that the tap is backed out at practically twice the speed at which it is advanced, thus effecting a material saving of time. A positive clutch is furnished on the horizontal shaft, by means of which the reverse driving mechanism can be disengaged when the tapping attachment is not in use.

The power feed mechanism is of very simple construction. Referring to Fig. 2, it will be seen that power is taken from the horizontal shaft by means of a cone pulley. From the small cone pulley, the power is transmitted through the worm and worm-wheel pivoted on the yoke, thence through the vertical shaft to a second worm and wheel which transmit power to the feed pinion. The lower worm is brought into engagement with the worm-wheel by means of a lever at the left-hand side of the sliding head. This lever,

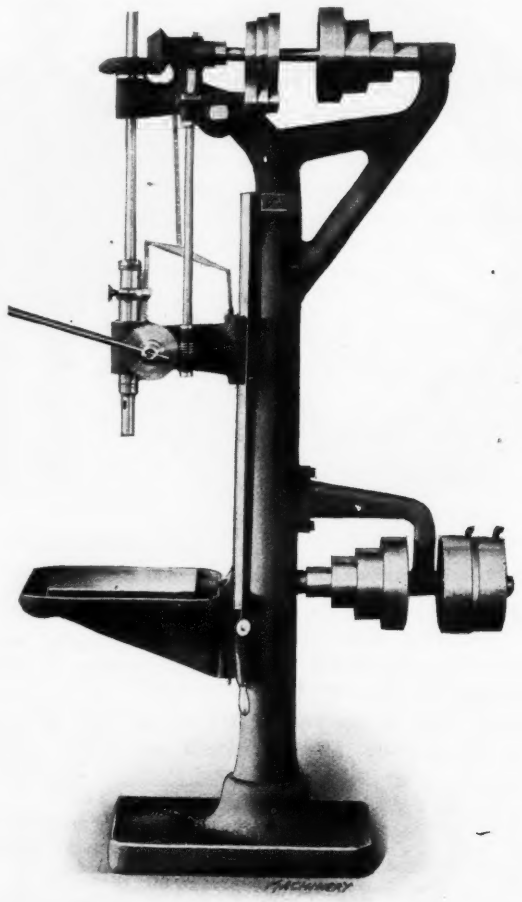


Fig. 2. Opposite Side of Drill shown in Fig. 1

when engaged with the trip finger, applies the power feed to the spindle until the adjustable stop on the sleeve comes into contact with the trip finger, at which time the power feed is automatically disengaged. An auxiliary lever is mounted at the end of the spindle feed shaft, permitting the feed to be operated by this hand lever when the power feed is disengaged or when using the tapping attachment.

The column is of tubular section and is bolted to the base. It is provided with a dovetailed face to which the sliding head and adjustable table are clamped. The column face is accurately planed and scraped into perfect alignment before the column is bored to receive the removable bronze bushings which carry the lower driving shaft, the top shaft and crown driving gear. This method insures perfect alignment of all moving parts. The sliding head is counterbalanced by a weight in the column and it may be clamped to the column face by means of a dovetailed gib. Suitable means of adjustment are provided to take up wear. The table is of the knee type and is raised or lowered by means of a rack and pinion actuated by a lever at the left-hand side of the machine. It is held in any desired position by means of a ratchet and pawl. The working surface of the table is entirely surrounded by an oil channel, and a binder lever clamps it to the column in any desired position.

The spindle is forged from crucible steel and finished by grinding. It is provided with a ball thrust bearing at the lower end of the sleeve and a bronze friction nut and hexagonal jam nut at the upper end of the sleeve. The sleeve is bronze bushed and graduated in inches; it is connected to the spindle feed shaft by means of a steel rack. A substantial depth gage extends entirely around the sleeve

and rack. The power feed will advance the spindle at the rate of 0.0055, 0.0081 and 0.0135 inch per revolution. There are four changes of speed, the available speeds being 110, 235, 460 and 990 revolutions per minute, which give suitable operating speeds for all sizes of drills within the range of the machine. These machines are manufactured by the Superior Machine Tool Co., Kokomo, Ind.

WHITCOMB-BLAISDELL PLANER

The Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., is now building the 17 by 20 inch planer shown in the accompanying illustration. While nominally a 17 by 20 inch machine, the actual capacity is 21 inches between the housings and 17 inches under the cross-rail. These planers are built with any length of bed from 4 to 10 feet inclusive. This machine replaces the 17 by 17 inch planer formerly manufactured by the Whitcomb-Blaisdell Machine Tool Co. It weighs approximately 1000 pounds more and is a slightly larger machine in every respect, all parts being made from new patterns of increased dimensions. It has been carefully designed to meet the requirements of modern machine shop practice.

The old 17 by 17 inch machine had a spur geared drive while the present machine is equipped with the "second belt drive" as successfully applied to all of the larger sizes of machines built by this company. In addition, an improved type of belt shifter cam has been incorporated in the design which is enclosed in a box on the inside of the bed, where it is thoroughly protected from dirt and chips. The belt eyes are of an improved type and the intermediate pinion and gear in the driving train are of the spiral type. This feature, combined with the second belt drive, does away with the possibility of noise from high-speed spur gears and gives a quiet, smooth running machine.

The machine is equipped with all of the features of the larger sizes of Whitcomb-Blaisdell planers including the cross head fastener; the patented shipper dogs, which are self acting, and may be released by a slight pressure of the finger; and the self-relieving friction box driven by a silent chain, which works with great precision and without drag. An automatic stop for vertical, angular and cross power feeds can be applied, which constitutes a useful feature to have on a machine for tool-room work, as it enables the toolmaker to start the machine working and set the stop, after which no further attention is required.

Particular attention has been paid to the provision of a strong drive, and with this idea in mind, the bearings for the shafts have been made of exceptionally large size. All bearings are self-oiling and the ways in the bed are provided with self-oiling rolls. When so desired, individual motor drive may be applied. For this purpose, the motor is either mounted on the housings and belted direct to the driving pulleys; or it is mounted on the floor or on a bracket secured to the bed of the planer and belted to a self-contained countershaft. A two- or three-horsepower motor is required, according to the character of the work and the speed at which it is desired to run the planer. The platen can be run at very high cutting speeds. For example, on bronze work a cutting speed of from 110 to 115 feet per minute is recommended, and operating under these conditions the planer is said to be capable of producing absolutely perfect work. This planer is well adapted for either tool-room or manufacturing work which comes within its range.

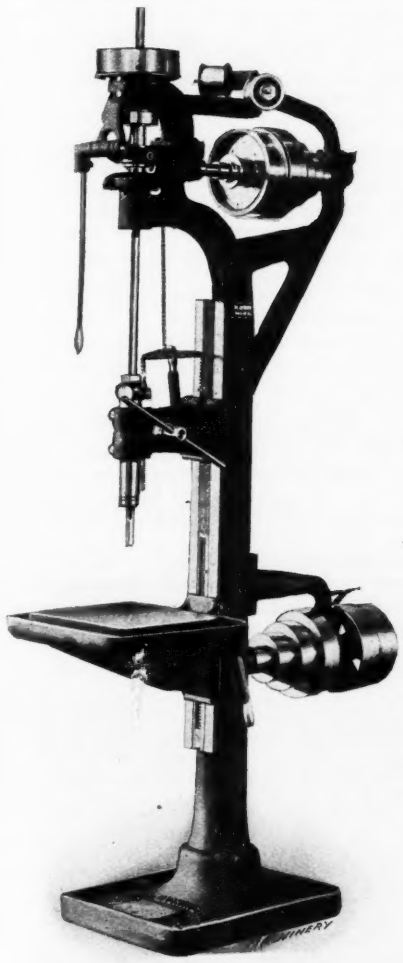
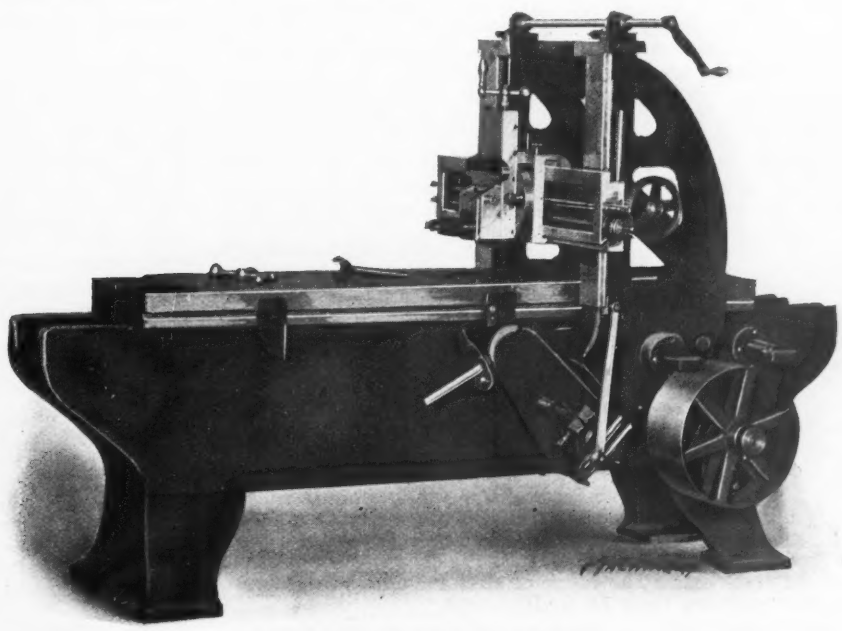


Fig. 3. Kokomo Drill equipped with Hand Feed



Whitcomb-Blaisdell 17 by 20-inch Planer

NEW MACHINERY AND TOOLS NOTES

Cleaning Gun: G. H. Dyer Co., 39 Piedmont St., Boston, Mass. A pneumatic cleaning device in the form of a gun which applies a blast of air to the required location. The air blast is controlled by a trigger.

Portable Welding Outfit: Dyer Apparatus Co., 39 Piedmont St., Boston, Mass. A portable welding outfit in which the torch is so arranged that a straight tube may be inserted instead of the bent tube when welding is to be done at the bottom of a hole.

Grinder: Royersford Foundry & Machine Co., 54 N. 5th St., Philadelphia, Pa. A floor type of dry grinder with an oil reservoir cored out of the head below the spindle. A wick with both ends dipping into the oil keeps the bearings continually lubricated. The bearings are dust-proof.

Oil Cup: Penn Pressed Metal Co., Camden, N. J. An oil cup formed from sheet brass and provided with a cap that has three projecting lugs. Normally the cap is closed through the action of a spring but it is easily opened by bringing the top of the oil-can spout into contact with one of the lugs.

Portable Welding Outfit: Metals Welding Co., Cleveland, Ohio. This outfit consists of the usual pair of tanks for holding the oxygen and acetylene together with suitable connections, flexible tubing and torches. The machine is built primarily for use in garages but is capable of application for use in other shops.

Rail Drilling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A rail drilling machine equipped with four spindles, the fourth being an auxiliary spindle. The three right-hand spindles are employed for the principal drilling operations. The machine is driven by a 10-horsepower Westinghouse motor.

Improved "Kwik-Kut" Machines: E. C. Atkins & Co., Indianapolis, Ind. The "Kwik-Kut" machines of this company's manufacture have recently been improved by the addition of a guide consisting of an upright, through which the blade passes to insure accuracy in cutting. A hydraulic attachment has also been added to regulate the blade pressure.

Lock-nut: Harvey J. Hipple, 121 Charlotte St., Lancaster, Pa. This locking device consists of a wire ring with one end of the ring extended at right angles to its plane. The ring goes between the nut and its seat and the end fits in a groove in the bolt. When the nut is screwed down, this end wire is bent over into the castellations in the nut.

Driving Wheel Lathe: Putnam Machine Co., Fitchburg, Mass. An improved model of the preceding machine of this type. In the new machine the feed is taken directly from the main driving shaft. The tailstock may be operated by an independent motor or from an independent countershaft. The driving shaft is of nickel steel and all gears are of steel.

Eight-spindle Drilling Machine: Edward Board, 619 Filbert St., Philadelphia, Pa. A machine for drilling the mixer ends of gas stove units. This consists of shallow drilling or "spotting." Eight drills ⅛ inch in diameter are used, which are spaced 3/16 inch apart around the arc of a circle. The burner to be drilled is clamped by means of an eccentric binder.

Friction Clutch: Carl G. Westlund Co., Worcester, Mass. A friction clutch made in a variety of sizes. All parts are split so that the clutch may be installed without requiring the shaft to be taken down. The working mechanism is entirely enclosed and all screws and nuts are set flush with the surface. The clutch is designed for both high and low speeds.

Drilling and Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine can be used either as a post drill or horizontally. The maximum length of feed of the spindle is 17 inches and three changes of power feed are provided in addition to hand adjustment of the spindle. The distance from the center of the spindle to the face is 14 inches.

Plate Shear: Long & Allstatter Co., Hamilton, Ohio. A plate shear which has a capacity for plates up to ⅜ inch in thickness and up to 16 feet wide. This machine is provided with the regular type of automatic hold-down for clamping the work which is used on shears built by this company. The slide is provided with an air balance in place of the usual weights.

Blueprint Finishing Machine: Revolute Machine Co., 417 E. 93rd St., New York City. A machine for washing, drying, ironing and finishing blueprints which are either in the form of separate sheets or in a continuous roll. The four essential parts of the machine consist of a washing tank, a wringer, a hot drying and ironing drum and an automatic winding device for long prints.

Open-gap Shear: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A motor-driven machine built for the Pennsylvania railroad for use in the Altoona shops. The machine is intended for shearing 0.40 per cent carbon bars 3 by 12 inches in size. The frame is of steel and the bearing surfaces are bronze bushed. Power is supplied by a 35-horsepower direct-connected motor.

Knuckle Joint Press: Max Ams Machine Co., Mount Vernon, N. Y. A line of embossing and swaging presses made in various sizes. The frames of all machines with a capacity for pressures exceeding 250 tons are reinforced by steel rods. The knuckle joints have adjustable wearing surfaces and hardened steel pins. The range of sizes includes presses with capacities varying from 50 to 1000 tons.

Pipe Fitting Tapping Machine: Pottstown Machine Co., Pottstown, Pa. A single-spindle machine for tapping flanges, single-end fittings and similar parts. The work is held in toggle operated chucks. Ample adjustment is provided on the machine to adapt it for turning out small lots of work quickly. Different sizes are built, the capacity of the largest machine being for fittings up to 12 inches in diameter.

Cutting-off Machine: Matson Machine Co., Concord, N. H. A cutting-off machine which has a capacity for round or square work up to 4½ inches in diameter or thickness. The machine is driven by a worm-gear and is provided with ball thrust bearings at the ends of the driving shaft and feed-screw. The feed is started by engaging a positive clutch which is automatically released. The range of feeds is from ⅛ to ⅜ inch per minute.

Screw Press: Pruyn & Bilodeau, 1876 Broadway, New York City. This machine is intended for use in machine and repair shops. It has columns mounted at each side of the bed which are 15 inches apart and distance pieces 5, 10 and 15 inches in length are provided. This arrangement enables the screw to be brought to any desired position for performing different operations. The table is 26 by 19 inches in size and has an opening in the middle.

Motor Starter: Cutler-Hammer Mfg. Co., Milwaukee, Wis. A high voltage automatic motor starter to provide for starting 1100 and 2200 volt A. C. squirrel cage motors used in industrial plants. The apparatus consists of a frame made of angle iron, upon which the high tension oil immersed solenoid switches, and the relays required to control the motor and auto transformer circuits are mounted. The starting switches are operated by single phase solenoids.

Motor Operated Shear Gage: Long & Allstatter, Hamilton, Ohio. A back gage for use on a shearing machine, which is driven by a ⅞ horsepower electric motor. The gage is provided with a lead-screw near each end for running it forward or away from the shear blade. The movement is controlled by means of a lever at the right-hand side of the machine. After the gage has been run out to an approximate setting, it may be accurately located by means of a handwheel.

Hand Drill and Drill Vise: North Bros. Mfg. Co., Philadelphia, Pa. The drill is provided with an automatic trip for disengaging the feed when the spindle has reached the extreme of its travel. The machines are built in two sizes with capacities for handling drills up to ¼ and ½ inch in diameter, respectively. The drill vise is 6 inches long by 2⅜ inches wide by 2 inches high. The jaws are 1⅜ inch deep and open 3 inches without the swivel jaw or 2⅝ inches with it.

Balance Indicator: Emery Johnson, Newberg, Oregon. A balance indicator, the operation of which is based on the principle that a perfectly balanced rotating disk which is loosely supported on its axis is free to move in any direction, although its axis may be unsteady. The instrument is momentarily applied to the end of the shaft to be balanced and if this shaft is unbalanced, the spindle of the indicator proceeds in a circuitous path while the disk seeks its own course and revolves steadily.

Pipe Fitting Tapping Machine: Pottstown Machine Co., Pottstown, Pa. A 5-way automatic tapping machine for tapping T's, L's, and Y's, crosses and other fittings of any angle and with side outlet. The tapping heads are carried on a plate which is slotted so that the heads may be adjusted to the required angle. Four spindles are carried in bearings mounted on this plate and a fifth spindle projects through the center of the plate. The spindles are fed in and out by means of interchangeable lead-screws.

Elevating Truck: Cowan Truck Co., Holyoke, Mass. This company has added to its line an elevating transveyor which has a lift of 3 inches and a capacity for handling loads up to 5000 pounds. This transveyor is known as the Type H and has been particularly developed for use in factories where it is required to load work into freight cars. For such service, it has been found that a truck capable of lifting work 1½ or 2 inches is not adequate. The large capacity of the truck enables material to be moved with greatly increased efficiency.

Air Compressors: Sullivan Machinery Co., Chicago, Ill. Two types of a power driven air compressor. The special feature of one of these machines consists of the combination of one horizontal and one vertical cylinder with both pistons driven from one crankpin on a center crank, and both valve gears driven from one crank disk on the end of the shaft. The other unit referred to is a small size single stage compressor. This unit is of the center crank, straight line, single stage type and is belt driven. The design is such that the crankshaft may be taken out and reversed end for end to provide for driving the compressor from either side.

Edging Machine: Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. A machine for edging drawn shells used in the manufacture of products made of pressed and formed steel. The machine takes the shell after it leaves the press, trims the ragged edge, smooths the edge and cuts the shell off to the desired length. The machine is semi-automatic in operation, the shells being fed into the hopper by the operator, after which they are carried automatically to a position directly in line with the chuck. The shells are then pushed into the chuck against a positive stop and the operations performed on them. Machines of this type are made in several styles to meet the requirements of different classes of work.

Horning Press: Cleveland Machine & Mfg. Co., Cleveland, Ohio. In the November, 1913, number of MACHINERY a wiring and horning press built by the Cleveland Machine & Mfg. Co., Cleveland, Ohio, was illustrated and described. This machine has a capacity for closing seams up to 12 inches in length and for wiring work up to 10 inches in diameter. Its weight was 1850 pounds. Since that time a larger machine of the same type has been added to the line of the Cleveland Machine & Mfg. Co. The large machine will close seams up to 20 inches in length and wire work up to 18 inches in diameter. The weight of the machine is 9000 pounds. Both of these machines are equipped with a knee pivoted on the left-hand side of the machine. When it is desired to use the press for horning operations, this knee is swung around out of the way and the horn is set up in a hole in the frame of the press provided for that purpose. In addition to the knee supported on the left-hand side of the press, the large machine is equipped with an auxiliary knee for use in wiring deep cans and similar classes of work. The auxiliary knee is pivoted from the right-hand side of the press, the method of support being the same for both knees.

ROSNER PROCESS OF WELDING HIGH-SPEED STEEL

A process for welding high-speed steel to low carbon steel has been developed by Adolph Rosner, of Bridgeport, Conn. This process enables a small piece of expensive high-speed steel to be fused or welded to a piece of low carbon steel to produce a tool for lathe or planer work, when a high-speed steel cutting edge is necessary. The piece of high-speed steel is not dovetailed or let into the carbon steel shank, but is welded to a flat surface making it one piece with the shank; and the strength of the union is such that the high-speed steel cannot be broken off by the pressure of the heaviest cut. The heat is radiated from the cutting point of a tool built up in this way as readily as in the case of tools which are made entirely of high-speed steel. The Rosner welded tools can be annealed, reshaped, machined over and rehardened as often as necessary. It is also possible to bend and forge such tools to a certain extent without breaking the weld, providing the operation is performed at a high temperature.

The cutting edge of a tool is the only part which need be made of high-speed steel. With ordinary tools, a lot of expensive high-speed steel is wasted in reforging and grinding the tool, but with the Rosner method the shank is made out of steel having from 0.20 to 0.30 per cent of carbon which can be bought for about two cents a pound. The welding is done in a gas furnace at a temperature of over 2000 degrees F.; a special flux is used, and the shank of the tool is cooled in water after completing the welding operation for the purpose of stiffening it. The problem of hardening tools is eliminated in the case of Rosner built-up tools, as the hardening is done at the same time that the welding is performed, but without the use of an air blast. Immediately after hardening, the tools are ready to be ground for use in the lathe or planer.

Die blocks can be made by the Rosner process of welding. For this purpose a thin layer of high-speed steel is welded to the top of the low carbon steel die block. Dies made in this way are much cheaper than those in which expensive steel is used for the entire die, and they do not shrink or crack in hardening. In making such dies, the pieces are machined very close to the desired shape and size before welding; and after the welding operation has been performed, the die will have to be annealed, machined to the required size and then rehardened. There are a great many special cutting tools,

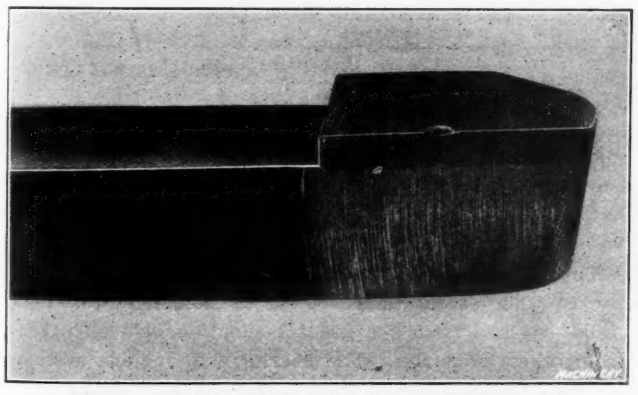


Fig. 1. A Built-up Tool welded by the Rosner Process

such as forming tools, used in machine shops, in which only a small part of the tool can be utilized. This process of welding a high-speed cutter to a shank of cheaper steel lowers the cost of such tools very materially. Cutters for boring bars can be made by welding a piece of high-speed steel to each end of a low carbon steel shank. When the cutter becomes too short through grinding, it may be brought back to the required length by peening the metal in the middle of the shank. The Rosner process has also been successfully applied for making the cutters used on a variety of wood-working machines.

The use of welded, built-up tools means a saving of from 30 to 40 per cent as compared with the cost of solid high-speed steel tools for use in the lathe or planer. The welded tools do not require any reforging and consequently the shop equipment for handling this work is not necessary. When a tool made entirely of high-speed steel has been ground down so that it is too short for further use, it does not pay to draw it out to a smaller section of greater length, because the cost per pound of drawing it out to this section is higher and the quality of the steel considerably lower than that of new metal. The expense of high-speed steel tools has been materially reduced by using tool-holders in which a small piece of high-speed steel is held by means of a set-screw. But these tools are not entirely satisfactory—especially for heavy and rapid cutting. It has been found that a small piece of high-speed steel inserted in a holder does not conduct the heat generated in cutting to the shank as well as a solid tool does. The result is that the cutting edge of the small tool does not stand up so well as that of a tool made of one piece of steel.

It is possible to weld high-speed steel to low carbon steel electrically, but this process cannot be applied in making lathe or planer tools. The reason is that in such electrically welded tools, the high-speed steel is full of fine cracks caused by the rapid heating of the metal, and these cracks result in the breaking of the cutter. To give satisfactory results, high-speed steel must be heated slowly. Oxy-acetylene welding cannot be used for the same reason. In addition, these processes do not unite the high-speed and low carbon steels firmly enough to enable a tool made in this way to stand up under the pressure of heavy cuts.

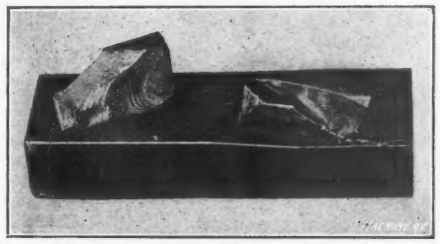


Fig. 2. Test of a Rosner Weld—the Steel broke first

The following outlines the expense involved in reforging and hardening a lathe or planer tool ¾ by 1½ by 10 inches in size made entirely of high-speed steel. It is estimated that a tool of such dimensions can be reforged and hardened six times, after which the tool will be only 4 inches long—allowing 1 inch for each reforging—and it is then too short to be used satisfactorily. This relation is shown diagrammatically in Fig. 4, where the cutting edge of the tool is marked *A*, the portion of the entire tool actually used *B* and the scrap *C*. The portion of the steel wasted in grinding is marked *D* and the metal cut off in reforging the tool, *E*. It will be evident that the scrap *C* amounts to 40 per cent of the entire tool.

First heating to 1500 degrees F.	4 minutes
Trimming and forging	2 minutes
Second heating	1 minute
Finish-forging	1 minute
Grinding	1 minute
Heating to 2100 degrees F. for hardening	3 minutes
Quenching	1 minute
Time lost in fixing the fire, etc.	2½ minutes
Total time	15½ minutes

Labor	
1 blacksmith	$0.30 per hour
1 blacksmith's helper	0.20 per hour
	$0.50 per hour
	$0.0083 per minute
15½ minutes at $0.0083	$0.1286
General shop expenses 60 per cent	0.0771
Actual cost one reforging and hardening	$0.2057

Good high-speed steel costs from seventy-five cents to $1.50 a pound. An ordinary lathe side tool, 10 inches long, which is made entirely of high-speed steel can be reforged and rehardened about six times, but about 40 per cent of the metal is lost as the tool becomes too short for use. The cost of reforging tools varies with the cross-section. The following tabular matter outlines the cost of reforging the tool six times, together with the cost of the material.

3 pounds of high-speed steel at seventy-five cents	$2.25
Reforging 6 times and rehardening at twenty cents	1.20
Total cost	$3.45
Value of scrap	.08
Net cost of one high-speed lathe tool	$3.37

For comparison with the all high-speed steel tool considered in the preceding discussion, we will consider a Rosner welded tool 10 inches long, which has a piece of high-speed steel 1½ inch long welded to it. It is estimated that five of these built-up tools will do the same work as one all high-speed steel tool of the same length and cross-section. When one Rosner tool is used up, a new one is obtained from the stock-room so that the tool is always of the most efficient length. The low

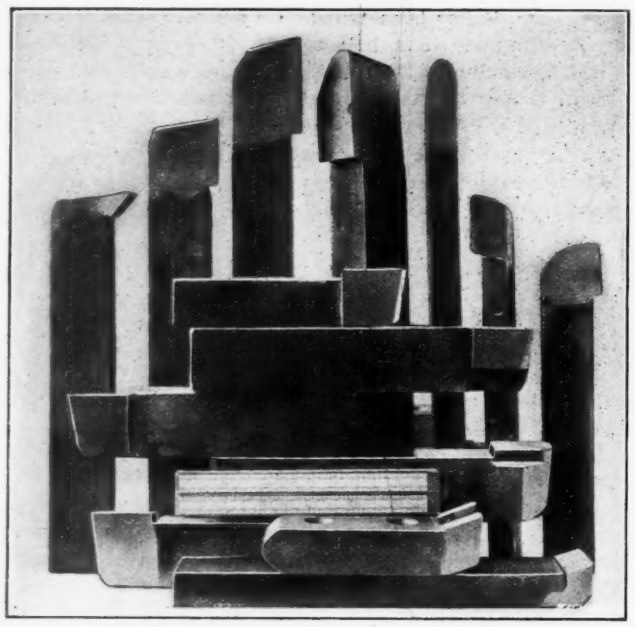


Fig. 3. A Group of Rosner Tools for the Lathe and Planer

carbon steel shank of a worn out Rosner tool may be scrapped or another piece of high-speed steel may be welded to it. On this basis the relative cost of tools of these classes would be as follows:

1 3-pound high-speed steel tool at seventy-five cents per pound and six reforgings $3.37
5 Rosner tools sold for forty cents each.. 2.00

Saving by using welded tools.....$1.37 = 41%

By using certain shapes, it is possible to get as much service out of three welded tools as can be obtained from one all

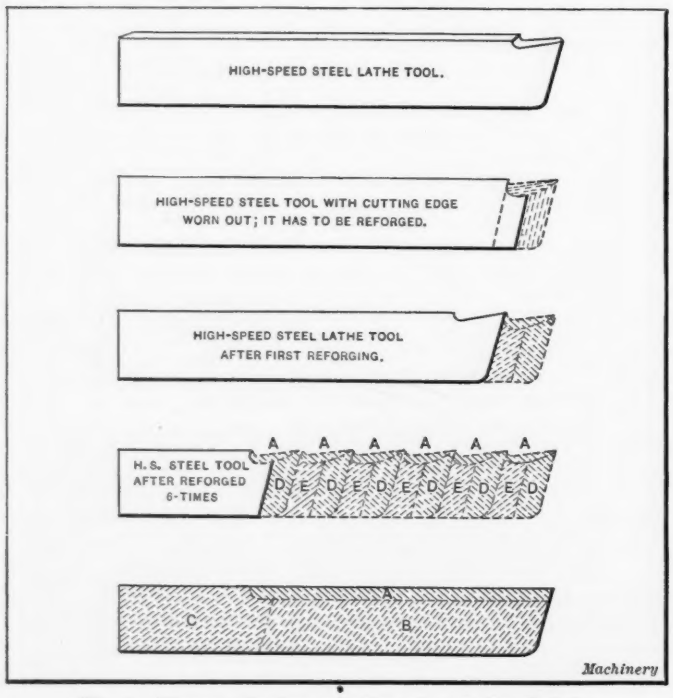

HIGH-SPEED STEEL LATHE TOOL.
HIGH-SPEED STEEL TOOL WITH CUTTING EDGE WORN OUT; IT HAS TO BE REFORGED.
HIGH-SPEED STEEL LATHE TOOL AFTER FIRST REFORGING.
H.S. STEEL TOOL AFTER REFORGED 6-TIMES
A A A A A A
D E D E D E D E D E D
C
B
Machinery

Fig. 4. Diagram showing reduction of a Lathe Tool in reforging and grinding

high-speed steel tool. To do this, the high-speed steel strip welded to the shank of the tool is longer than that ordinarily employed. With such tools, a comparison of efficiency would be as follows:

1 3-pound all high-speed steel tool at seventy-five cents per pound and six reforgings $3.37
3 Rosner tools sold for sixty cents each.. 1.80

Saving by using welded tools.....$1.57 = 47%

As the results of extensive experience in the use of these tools are not available, the comparisons drawn cannot be regarded as iron-clad. They are, however, sufficiently close to give a very fair approximation of the saving made possible through the use of high-speed steel cutters welded to shanks made of less expensive material.

* * *

U. S. COMMISSION ON INDUSTRIAL RELATIONS

The United States Commission on Industrial Relations will hold its first formal public hearing in Washington, April 6, at which collective bargaining, conciliation and arbitration as means of adjusting differences between employer and employe will be considered. Corporation officials and trade union leaders who have negotiated and maintained trade agreements

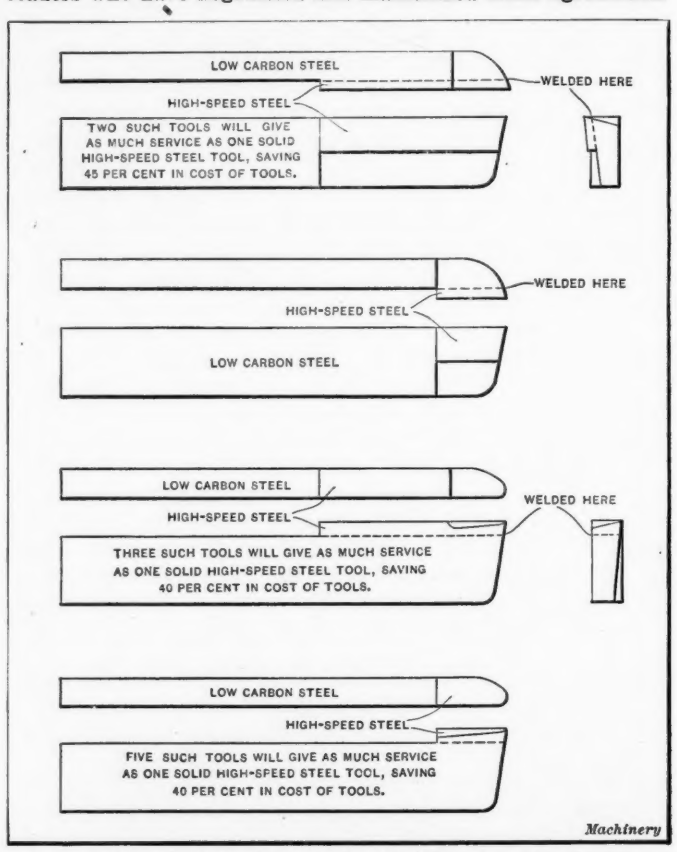

LOW CARBON STEEL
WELDED HERE
HIGH-SPEED STEEL
TWO SUCH TOOLS WILL GIVE AS MUCH SERVICE AS ONE SOLID HIGH-SPEED STEEL TOOL, SAVING 45 PER CENT IN COST OF TOOLS.
WELDED HERE
HIGH-SPEED STEEL
LOW CARBON STEEL
LOW CARBON STEEL
WELDED HERE
HIGH-SPEED STEEL
THREE SUCH TOOLS WILL GIVE AS MUCH SERVICE AS ONE SOLID HIGH-SPEED STEEL TOOL, SAVING 40 PER CENT IN COST OF TOOLS.
LOW CARBON STEEL
HIGH-SPEED STEEL
FIVE SUCH TOOLS WILL GIVE AS MUCH SERVICE AS ONE SOLID HIGH-SPEED STEEL TOOL, SAVING 40 PER CENT IN COST OF TOOLS.
Machinery

Fig. 5. Rosner Built-up Lathe Tools with Points of Various Lengths

in five of the nation's largest industries will be called to testify. The commission hopes to elicit information that will disclose to what extent improvement in industrial relations might be expected from the general adoption of such agreements in other industries. The hearing will include systematic efforts at peaceable settlement of disputes in the coal mining industry, railroads, clothing and printing trades, the building trades and the molders' trade.

* * *

COLONIAL EXPOSITION IN SEMARANG

A Colonial Exposition will be held in the city of Semarang, Java, Dutch East Indies, in the months of September-November, 1914, to celebrate the centennial of the return of the Dutch East Indies under Dutch rule after political affairs in Europe had been readjusted following the defeat of Napoleon and his banishment to St. Helena. The Dutch East Indies, of which Java, Sumatra, Borneo and Celebes are the principal islands, and which, geographically speaking, form a link between the mainland of Asia and Australia, have a population of over 30,000,000 inhabitants. Further information regarding the Colonial Exposition may be obtained from T. Greidanus, 136 Water St., New York City.

PRESENTATION OF THE E. H. HARRIMAN MEMORIAL MEDALS

The presentation of the E. H. Harriman memorial medals awarded by the American Museum of Safety to the Southern Pacific Co. was made Saturday evening, March 14, in the beautiful studio of A. A. Anderson, 80 West 40th St., New York City. The gold medal was awarded to the Southern Pacific Co., represented by Julius Kruttschnitt, chairman of the executive board, at the annual dinner of the American Museum of Safety, December 12, but the actual presentation of the medals was deferred until the names of the operating official and the employe most deserving of the honor were known. The gold medal is given to the railroad company that has done most for the safety of passengers and employes during the year, a replica in silver to the member of the operating department of the road who has done the most to bring about this condition and a replica in bronze to the employe of the winning road who has been the most conspicuous in the promotion of safety by suggestions or otherwise.

The gold medal was presented to Julius Kruttschnitt by Mrs. E. H. Harriman, assisted by Arthur Williams, president of the American Museum of Safety, who presided; the silver medal was presented to William Sproule, president of the Southern Pacific Co., and the bronze medal to William Schwab, conductor on the Sacramento Division. Mr. Schwab traveled a distance of over 3000 miles across the continent to be present. In acknowledging the receipt of the medal, Mr. Schwab mentioned the encouragement that he had received from the superintendent of the Sacramento Division to make safety suggestions. He cited an example of the suggestions made. Two stations, Fair Oaks Bridge and Fair Oaks Junction, are only two miles apart, and the names are so similar that confusion often resulted and mistakes in reading train orders were made. Mr. Schwab suggested that the name of one of the stations be changed to avoid the confusion, which was immediately done. Mr. Kruttschnitt, in receiving the gold medal, spoke of the great volume of traffic on the Southern Pacific Co., and the team work necessary to conduct such great operations without serious accidents and loss of efficiency. Not one passenger has been killed in the past five years, though 41,783,000 passengers were carried 1,756,482,000 miles. Mr. Sproule, president of the Southern Pacific Co., said that the record was made possible by the loyalty of the men and their general cooperation.

The E. H. Harriman memorial medals are awarded yearly to the railroad that has made the best record for safety of life and limb of passengers and employes. It was especially gratifying to the principals concerned that the first award should go to the Southern Pacific Co., the reorganization of which had been an important part of Mr. Harriman's work.

Mr. Williams announced that the American Museum of Safety has been assigned the awarding of another annual medal, this being the Anthony N. Brady memorial medal for the street railways making the best safety records.

* * *

PERSONALS

Roland Cole of Rochester, N. Y., has joined the Ferro Foundry & Machine Co., Cleveland, Ohio, as advertising manager.

M. P. Fillingham has been appointed district sales manager for Van Dorn & Dutton Co., Cleveland, Ohio, with an office at 50 Church St., New York City.

William Sloane Accles, European manager of the Niles-Bement-Pond Co., sailed from Southampton, England, on the *Olympic* February 18 for a visit to the United States.

Joseph M. Schaeffer, European representative of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., sailed for England on the *Minnetonka* February 28.

Dyer Smith, patent attorney, has removed from the Woolworth Bldg., New York City, to 32 Liberty St., where he is now associated with Samuel O. Edmonds in the practice of patent and trade-mark law.

Harry A. Hey, office manager of the American Society of Mechanical Engineers, New York City, has resigned to become assistant to Henry Souther, vice-president of the Ferro Foundry & Machine Co., Cleveland, Ohio.

George A. Gallinger of Pittsburg, Pa., has been placed in charge of the pneumatic tool department of the Ingersoll-Rand Co., with the title of manager of pneumatic tool sales. His headquarters will be at 11 Broadway, New York City.

Harry E. Harris has taken a position as consulting engineer with the Greenfield Tap & Die Corporation, resigning his former position as superintendent of the Wells Bros. Co., now a division of the Greenfield Tap & Die Corporation.

Charles T. Lamb, for many years assistant treasurer and office manager of the F. E. Reed Co., Worcester, Mass., manufacturer of Reed lathes, and for the past two years office manager of the Reed-Prentice Co., has resigned, to take effect May 1. Mr. Lamb will engage in other business.

Dr. W. M. Leiserson, state superintendent of employment offices in Wisconsin, has been engaged by the United States Commission on Industrial Relations to take charge of its investigations into irregularity of employment and to assist in formulating recommendations for remedial legislation.

Frank A. Mossberg, president of the Frank Mossberg Co., Attleboro, Mass., was re-elected president of the board of trade of Attleboro at the annual meeting, February 18, and was also presented with a loving cup for his energetic and able services in the interests of the association during the past year.

Henry Souther has been elected vice-president and general manager of the Ferro Foundry & Machine Co., Cleveland, Ohio. Mr. Souther is a graduate of the Massachusetts Institute of Technology and for some years was consulting engineer to the Association of Licensed Automobile Manufacturers.

Robert W. Barwood of Philadelphia, an experienced machine tool salesman, has made an agreement with the Carter & Hakes Co., Winsted, Conn., to act as its representative in New England and the territory adjacent to New York and Philadelphia. Mr. Barwood's headquarters will be the Bourse, Philadelphia.

A. J. Borget, formerly of the Chalmers Motor Car Co., Detroit, Mich., has been made district sales manager of the Van Dorn Electric Tool Co., of Cleveland, Ohio, manufacturer of portable electric tools. Mr. Borget's office is at 1013 Mutual Life Bldg., Buffalo, N. Y. He will cover the territory in New York State west of Rochester.

A. B. Hazzard, general manager of the J. Morton Poole Co., Wilmington, Del., for the past six years, has resigned to take a position on the staff of managers of the Detroit Engine Works, Detroit, Mich. The employes of the J. Morton Poole Co. presented Mr. Hazzard with a loving cup February 21, and a farewell dinner was tendered him by his friends at the Hotel DuPont, at which a number of handsome presents were given him as tokens of kindly remembrance.

A. S. Baldwin, for the past three years general manager of the Alberger Pump & Condenser Co., Newburg, N. Y., builder of turbines, condensers, vacuum pumps, Corliss engines, ice machines and all types of centrifugal pumps, has resigned his position. Mr. Baldwin was for four years and a half superintendent of shops for the Driggs Seabury Ordnance Corporation of Sharon, Pa., and previous to that superintendent of the American & British Mfg. Co., of Bridgeport, Conn., for two and one-half years.

* * *

OBITUARIES

Robert C. Moodey, president of the Cleveland Machine & Mfg. Co., and several other corporations, died in Cleveland, March 15, aged fifty-six years.

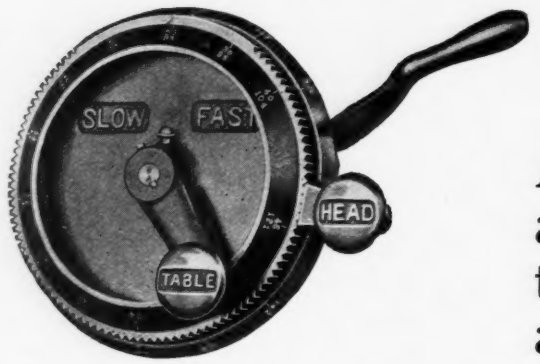
Adolph Zuest, vice-president and treasurer of the G. A. Gray Co., of Cincinnati, Ohio, died on February 19 following an attack of pneumonia. Mr. Zuest was fifty-nine years of age and a bachelor. He was born in Cincinnati, and for over twenty-seven years had been connected with the G. A. Gray Co. Mr. Zuest's engaging personality and kindly manner made many friends among those having business relations with that company and in the circle, who regarded him highly. His loss will be greatly felt by his business associates.

GEORGE WESTINGHOUSE

George Westinghouse, the famous inventor and engineer, died of heart disease at his New York City residence March 12, aged sixty-seven years. His health had been failing for some time and consequently his death, though a great shock to his friends and acquaintances all over the country, was nevertheless in a measure anticipated. The mental alertness and wonderful vitality that had so characterized his brilliant career remained with him to the end. Although actively associated with a large number of industries, he had during the last few years begun to transfer his responsibilities to the shoulders of his trusted lieutenants, the fortunate selection of which has always been one of the leading characteristics of his varied career.

Mr. Westinghouse was born at Central Bridge, Scholarie Co., N. Y. His father was an inventor, who, in 1856, removed his family to Schenectady, N. Y., where he established

How the Work is Controlled From One Point



A system of starting, stopping and changing work speed and table traverse operated as easily as an electric controller.

If you have ever operated a grinding machine you realize how important this feature is.

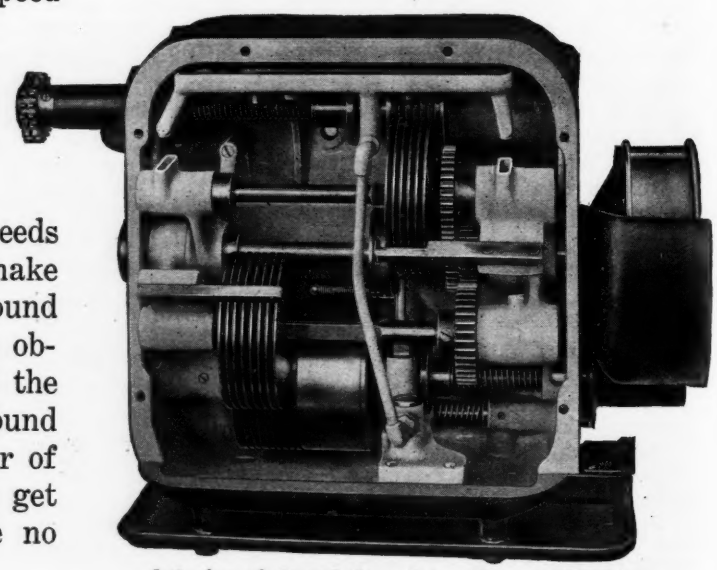
The dial shown above is located within convenient reach of the operator's left hand. One of the levers controls the head or rotation of the work, the other changes the rate of table traverse. The long lever serves to instantly stop and start both work and table simultaneously, without stopping the wheel.

There are no belts to shift, and no cone pulleys are used. The work speed and table traversing mechanisms, as shown in cut opposite, are driven by a constant speed pulley.

The changes of speed for work and table are entirely independent. This allows combinations of fast speeds and slow feeds or *vice versa*. To make changes the proper lever is moved around the dial until the desired speed is obtained, figures on the dial giving the rate of speed. Note the notches around the edge indicating the large number of speeds available. You can always get just the right speed, for there are no long jumps.

On starting a new piece it is rather difficult to guess exactly the right work speed and table travel the first time. But with this mechanism there is no temptation to let a wrong speed stand. It is just as easy to adjust the two levers until the combination best suited to the work is obtained.

It is also easy to grind several diameters on one piece at the correct speeds, because the changes are so quickly made.

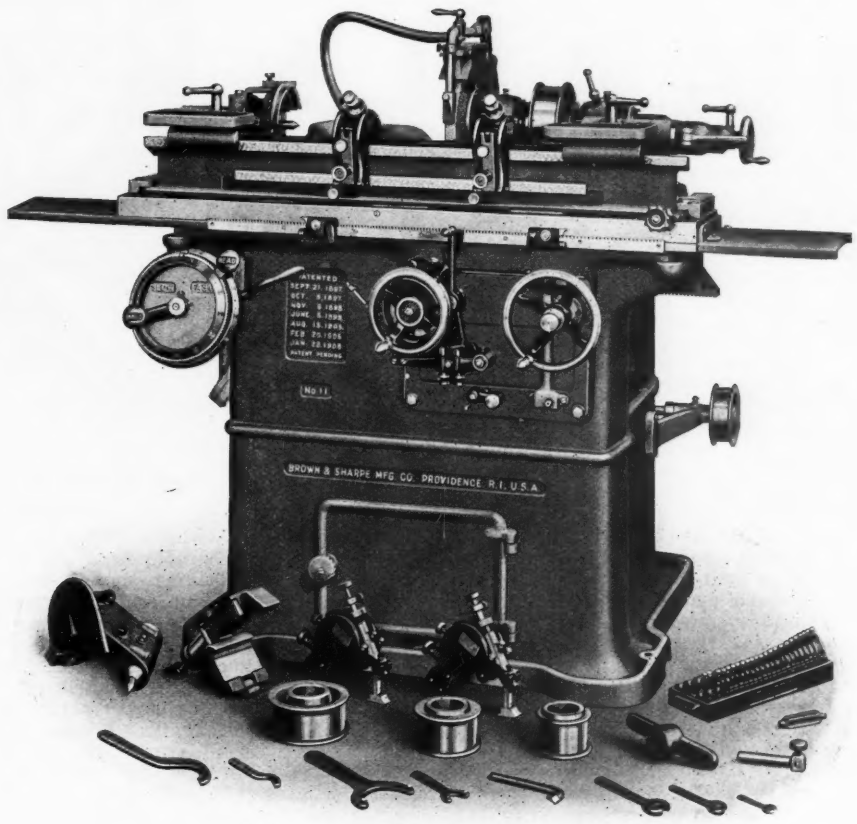


Interior of Speed Case from Rear of Machine

BROWN & SHARPE MFG. CO.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa. 626-30 Washington Blvd., Chicago, Ill. 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419, University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O.; Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.



No. 11 Plain Grinding Machine

The principle of the mechanism of the speed case shown opposite is simple. A series of several tapered friction disks, rotating at constant speed, transmit power to a series of recessed disks. The disks interlock and the point of contact is on the edge of each recessed disk. Thus, as one series is swung toward the other, the part of the disk actually driving decreases in radius and the speed decreases.

There are two of these mechanisms in the case, one for driving the work, the other for the table. Powerful springs serve to hold the disks in contact, the whole furnishing ample power for all work within the machine's capacity.

The No. 11 Plain Grinding Machine in addition to the new speed changing mechanism embodies many other features which make it an easily operated machine for handling the most accurate classes of work in large quantities.

Have you ever investigated our automatic cross feed which can be set to grind to a required diameter and then automatically release? It feeds as fine as one quarter-thousandth for each traverse and is quickly set to remove any desired amount on the diameter.

Then there are the Universal Back Rests which follow the work down to the required diameter with equal pressure to a positive stop. If you are interested in these production points we will send you a circular.

PROVIDENCE, R. I., U. S. A.

Canadian: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow; F. G. Kretschmer & Co., Frankfort, a/M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France, Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; The F. W. Horne Co., Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I.

Read page 75

the Schenectady Agricultural Works. The boy attended the public and high schools of the town, spending much of his leisure time, after studies, in his father's machine shop. What to other lads would have been regarded as irksome and confining young Westinghouse found to be a source of amusement and instruction. Before he was fifteen he invented and made a rotary engine, and passed at an early age the examination for the position of assistant engineer in the United States Navy. Following honorable military service from 1863 to 1865, he entered Union College, where he remained until the close of his sophomore year, and obedient to his impulse toward experiment, abandoned his classical studies and entered upon active life, to find a wider scope for his inventive genius. In 1865 he invented a device for replacing railroad cars upon the track, which, being of cast steel, was manufactured by the Bessemer Steel Works, at Troy, N. Y. Going to Troy one day, a delay caused by a collision between two freight trains, suggested to Mr. Westinghouse the idea that a brake under the control of an engineer might have prevented the accident. His first thought was an automatic brake attached to the couplers which was unsuccessful. This was followed by steam, which proved also to be unsatisfactory because by the time it reached the brake from the engineer's cab it had lost its power. At this point fate seems to have entered his life. In the pages of a magazine he had subscribed to, through the solicitation of a young girl, he saw an account of the use of compressed air in digging the Mont Cenis Tunnel, three thousand feet under ground. Instantly the inventor saw light. After much further study and investigation, the feasibility of compressed air further impressed itself on him. Drawings of the air-pump, brake cylinder and valves were made, but considerable time elapsed before a practical trial of the brake was obtained. The first patent was issued April 13, 1869, and the Westinghouse Air Brake Co. was formed on July 20 following.

About 1880 Mr. Westinghouse became interested in the operation of railway signals and switches by compressed air, and soon after there was developed and patented the system now manufactured by the Union Switch & Signal Co. The pneumatic interlocking switch and signal apparatus, whereby all the signals and switches are operated from a given point, using compressed air as the motive power and electricity to bring that power into operation, has been successfully introduced in Boston, Jersey City, Philadelphia, Chicago, St. Louis, and many other places. In 1886 the Westinghouse Electric Co. was formed for the manufacture of lamps and electric lighting apparatus, Mr. Westinghouse having become interested in the subject. The business rapidly developed, and in 1889 and 1890 this company absorbed the United States Electric Co. and the Consolidated Electric Light Co. In 1891 all these properties were reorganized into the Westinghouse Electric & Mfg. Co., which owns extensive works at East Pittsburg, employing over 22,000 people.

The question of the steam turbine and its applications was investigated by Mr. Westinghouse and he secured the patent rights of Charles A. Parsons of England on the turbine in 1897-98. This development of a new prime mover soon led the inventor to consider the use of the turbine as a prime mover for ships. The trouble was the high speed. Mr. Westinghouse then developed and brought out one of the most ingenious devices of modern engineering. This was the mechanical reduction gear for reducing the inherently high speed of a turbine to the slow speed of a ship propeller or direct-current dynamo. He accomplished this work in collaboration with the late Rear Admiral George W. Melville, U. S. N., and John H. MacAlpine. Within the last few years he also occupied himself with the development of an air spring for automobiles and motor trucks.

Mr. Westinghouse rendered an invaluable service to the electrical development of the world when, in spite of opposition, ridicule and all the unfair efforts to crush his alternating-current system, he remained steadfast in his belief that this class of high-tension transmission would make distant electrical distribution possible. This system his engineers developed, and, incidentally, secured the cooperation of Nicola Tesla, 1887, who invented the alternating-current induction motor. The world today, lighted by distant waterfalls and central stations, now recognizes its debt to Mr. Westinghouse's foresight and perseverance. A struggle almost identical with that of the earlier fight for alternating-current transmission is the recent development of alternating-current traction by means of the single-phase motor which the Westinghouse Electric & Mfg. Co. has now wrought into an accomplished reality in the case of a number of traction lines, railroad terminals and tunnels.

George Westinghouse

Originating with the air brake, the growth of the various Westinghouse industries has been largely identified with railway progress, and it is interesting to note that this progress has represented increased security of life, increased capacity of the railway and reduced cost of operation. It is simply stating a fact to say that Mr. Westinghouse has been a great factor in the advance of civilization as represented by the important part he has played by introducing improved means of transportation. When the apparatus had passed the experimental state and was ready for commercial exploitation, he established factories which are themselves models, and which show the same anticipation of future development. Not only are the buildings handsome and well equipped with the best tools, but the comfort of the employes has been generally considered. It is worth noting that the nine-hour day, or rather the fifty-four week, was started with the Westinghouse Air Brake Co. in 1869, and has been adopted in all the other works as they were established.

Owing to his many achievements in mechanics, electricity, steam and gas, his name was known the world over, and he had many honorable distinctions conferred upon him for his achievements and in recognition of the services he rendered the various branches of engineering. He was an honorary member of the American Society of Mechanical Engineers, of which body he was also president in 1910. He was one of the two honorary members of the American Society for the Advancement of Science. He received the Edison gold medal for meritorious achievements in the alternating-current system of electrical distribution and the Grashof gold medal from the Society of German Engineers in Germany, which acknowledged him the greatest American engineer.

Mr. Westinghouse was connected with a large number of industries at home and abroad, many of which bore his name. These companies employ 50,000 men, and are capitalized at $200,000,000. He was married in 1867 to Marguerite Franklin Walker. His widow and son George survive him.

COMING EVENTS

April 4-11.—First National Efficiency Exposition and Conference, Grand Central Palace, New York City. Walter H. Tallis, director, Efficiency Society, Inc., 41 Park Row, New York City.

April 18-25.—Better Industrial Relations Exhibit at 2 W. 64th St., New York City. The exhibit will show the devices in modern business which tend to make more harmonious the relations between employer and employe and to better the conditions of employment. C. J. Primm, exhibit manager. Further information can be obtained from J. R. Rankin, 2 W. 64th St., New York City.

April 21-22.—Annual meeting of the National Metal Trades Association, Worcester, Mass. Hotel Bancroft, headquarters. H. D. Sayre, secretary, Peoples Gas Bldg., Chicago, Ill.

April 23-24.—Semi-annual convention of the National Machine Tool Builders' Association, New York City. Hotel Astor, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

April 29-30.—Annual meeting of the National Association of Cotton Manufacturers, Boston, Mass., in the Paul Revere Hall of the Mechanics Bldg. C. J. H. Woodbury, secretary, 45 Milk St., Boston, Mass.

May 1-October 31.—Anglo-American Exposition, London, England, to celebrate the centenary of peace between the United States and Great Britain. American executive offices: Woolworth Bldg., New York City. Charles J. Kiralfy and Albert E. Kiralfy, commissioners general.

June 10-12.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 15-17.—Annual convention of the American Supply & Machinery Manufacturers' Association at White Sulphur Springs, West Virginia; New Green Brier Hotel, headquarters. General offices of the association, Woolworth Bldg., New York City.

June 16-19.—Spring meeting of the American Society of Mechanical Engineers, Minneapolis and St. Paul, Minn. Calvin W. Rice, secretary, 29 W. 39th St., New York City.

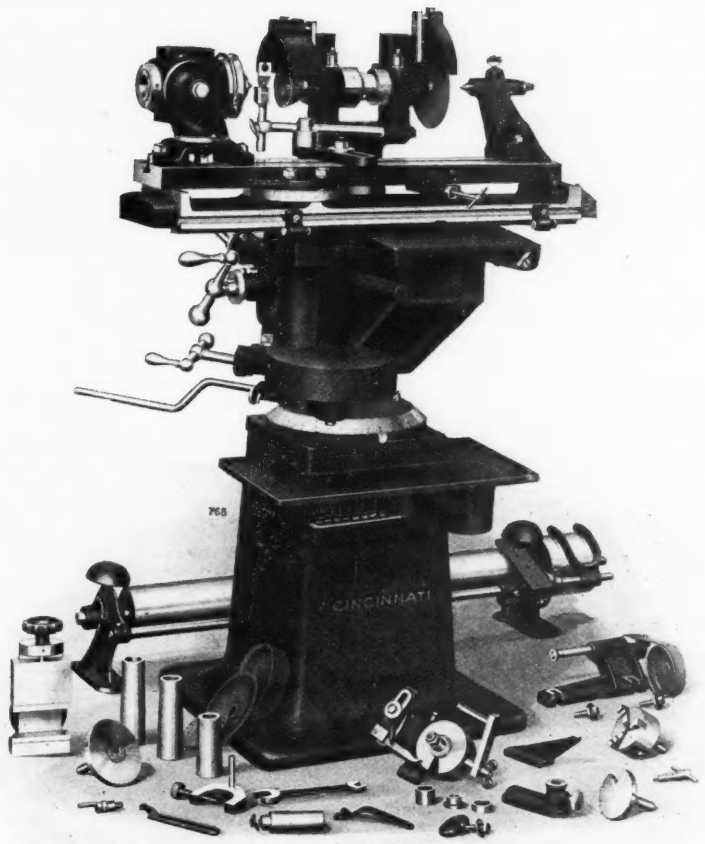
June 30-July 4.—Annual meeting of the American Society for Testing Materials, Atlantic City, N. J. Hotel Traymore, headquarters. Edgar Warburg, secretary, University of Pennsylvania, Philadelphia, Pa.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

The Pentane Lamp as a Working Standard. By E. C. Crittenden and A. H. Taylor. 17 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 216 of the Bureau of Standards, Vol. 10.

CLEARANCE



The No. 1½ Cincinnati Universal Cutter and Tool Grinder

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Incorrect cutter clearance will reduce the output of your milling machines twenty per cent.

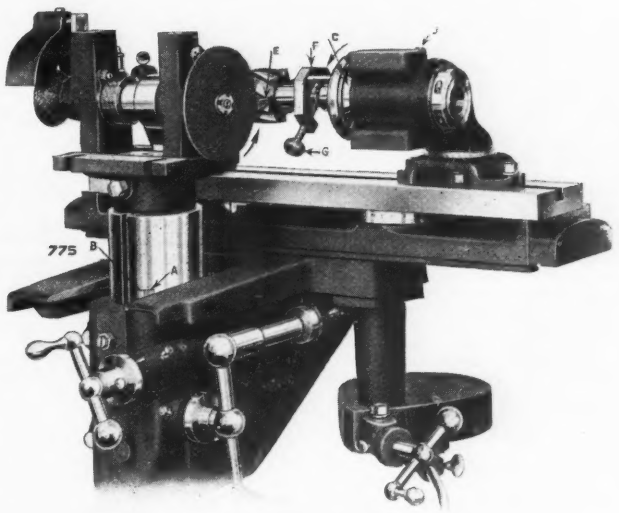
Clearance depends upon certain mathematical relations between the cutter and the grinding wheel.

To obtain these on the ordinary grinder requires several measurements and reference to diagrams, tables or charts.

The average operator doesn't understand these and after a couple of trials grinds until the clearance looks right—and your milling department suffers.

Compare the Cincinnati method. After a simple preliminary setting the swivel head is revolved the desired amount, the clearance angle being read directly from the dial—and your milling department profits.

This is only one of our *exclusive features.*



Method of setting for clearance.

Catalogue tells them all.

Cincinnati Milling Machine Company

CINCINNATI **OHIO, U. S. A.**

Modern Punch and Die Construction. Third revised and enlarged edition. 48 pages, 6 by 9 inches. Published by the Industrial Press, New York City. Price, 25 cents.

The Testing of Barometers. 12 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular 46 of the Bureau of Standards.

Fuel Briquetting Investigations. By C. L. Wright, 277 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 58.

Micrometer Microscopes. By Arthur W. Gray. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 215 of the Bureau of Standards, Vol. 10.

Note on the Setting of a Mercury Surface to a Required Height. By M. H. Stillman. 6 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Reprint 214 of the Bureau of Standards, Vol. 10.

Mud-laden Fluid Applied to Well Drilling. By J. A. Pollard and A. G. Heggem. 21 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 66.

Hydraulic Mine Filling with Reference to Its Use in the Pennsylvania Anthracite Fields. By Charles Enzian. 77 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 60.

The Action of Acid Mine Water on the Insulation of Electric Conductors. By H. H. Clark and L. C. Ilsley. 26 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Technical Paper 58.

Accuracy of the Formulas for the Ratio, Regulation and Phase Angle of Transformers. By P. G. Agnew and F. B. Silsbee. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as No. 211 of the Scientific Papers of the Bureau of Standards.

How to Build Up Furnace Efficiency. By Joseph W. Hays. 126 pages, 5 by 7½ inches. Illustrated. Published by the author at Rogers Park, Chicago, Ill. Price, $1.

This book, which is the seventh edition, revised and enlarged, treats of fuel waste, how to find fuel wastes and how to stop them. The treatise is one that can be profitably studied by fuel users in general.

Machine Forging. By Douglas T. Hamilton. 36 pages, 6 by 9 inches. 36 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This book describes the machines and methods used in the forming, welding and upsetting of machine parts by modern forging machinery. Typical machines are shown and a great number of examples of operations are illustrated with line-engravings. Applications to the automobile field and to the engine-building field are especially prominent.

The Mortar-making Qualities of Illinois Sands. By C. C. Wiley. 44 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill., as Bulletin 70.

The bulletin discusses the effects of the characteristics of the sand upon the quality of mortar. The results of a series of tests on thirty-two representative Illinois sands are given in tabular form and are discussed. A classification of different sands is then proposed and specifications for each sand suggested.

Electric Toy Making for Amateurs. 206 pages, 5 by 7 inches, 77 illustrations. Published by Norman W. Henley & Son, New York City. Price, $1.

This work treats of the making of electrical toys, apparatus, motors, dynamos and instruments in general. Its popularity is attested to by the fact that it has passed into the twentieth edition. The work has been revised and several new chapters added, thus bringing it up to date. The contents by chapter heads are Batteries, Permanent Magnets, Electromagnets, Electric Motors, Electric Bells, Miscellaneous Toys, Spark and Induction Coils and Allied Subjects, Hand Power Dynamo, Miscellaneous Receipts and Formulas, etc.

Bevel Gearing. By Ralph E. Flanders. 48 pages, 6 by 9 inches. 38 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is the fourth edition of this popular book, of which 28,000 copies have been published. This edition is practically the same as the third, except that part of the chapter on the strength and durability of bevel gears has been revised. The book contains seven chapters, headed as follows: Bevel Gear Rules and Formulas; Examples of Bevel Gear Calculations; Systems of Tooth Outlines used for Bevel Gearing; Strength and Durability of Bevel Gears; Design of Bevel Gearing; Machines for Cutting Bevel Gear Teeth; and Cutting the Teeth of Bevel Gears.

High-speed and Carbon Tool Steels. 44 pages, 6 by 9 inches. 16 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This treatise is No. 117 of MACHINERY's Reference Books. It contains a collection of the best articles that have been published on the subject in MACHINERY during the past few years. The first chapter gives specifications for high-speed and carbon tool steel used in the United States navy yards. Chapter II is on the relation of the price of tool steel to manufacturing costs. Chapter III deals with the influence of heat on hardened tool steels with relation to their cutting qualities. Chapter IV is quite a complete review of the development and use of high-speed steel, while Chapter V deals in detail with the hardening and tempering of steel, giving specifications for quenching baths and tempering baths, and showing illustrations of practical designs of tanks for these baths.

Arbors and Work-holding Devices. 48 pages, 6 by 9 inches. 53 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This is No. 120 of MACHINERY's Reference Books and contains a number of chapters dealing with holding devices and appliances used when turning, boring and grinding work of difficult and unusual character. The devices are all illustrated by line engravings showing, in detail, the design and constructional features. Two of the chapters contain the descriptions of the holding devices for first and second operation work recently published in articles in MACHINERY by Albert A. Dowd. One chapter shows devices designed by the Jones & Lamson Machine Co. for holding work in the Fay automatic lathe. These devices, however, are applicable to any engine lathe. This book will be of especial value to all tool designers and to other mechanics who have to devise ways and means for setting up work in lathes and boring mills.

Bolt, Nut and Rivet Forging. By Douglas T. Hamilton. 43 pages, 6 by 9 inches. 44 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

This book contains the articles on bolt, nut and rivet forging machinery, methods and operations which have appeared in MACHINERY during the past year. The book is divided into three chapters, the first of which deals with bolt heading machines of a general type, describing the main features of their construction and operation; the second chapter deals with continuous-motion bolt and rivet headers, and the third with nut-forging machines. Tables of standard proportions of forged bolts and nuts are included. The book deals with a subject on which little has been published, and will, therefore, be of interest as a record of the present state of this branch of the forging art; it should appeal both to those directly interested in this field and to mechanics in general, who wish to keep informed on the progress of their trade as a whole.

The Manufacture of Steel Balls. By Robert H. Grant. 48 pages, 6 by 9 inches. 40 illustrations. Published by the Industrial Press, New York City. Price, 25 cents.

Little has been published on the manufacture of steel balls, no complete review of the process of manufacture ever having been attempted. In fact, no treatise on this subject has been published except a number of articles by Mr. Grant, which appeared two years ago in MACHINERY. These articles have been collected in the book under review and present a complete description of the manufacture of steel balls, including a historical review; the book begins with the various methods employed for making the blanks, rough-grinding, hardening and finish-grinding the balls, concluding with a chapter on the inspecting, gaging and testing of balls. Being the only treatise on this subject published, it will, no doubt, appeal to mechanical men in general, who are interested in the somewhat unique processes employed in this specialized manufacture.

Experimental Mensuration. By H. Stanley Redgrove. 328 pages, 4¾ by 7¼ inches. Illustrated. Published by D. Van Nostrand Co., New York City. Price, $1.25.

The author presents the science of geometry by the inductive rather than by the deductive system. He holds that the argument in favor of the old style geometry as providing for a training of the faculty of deduction must be given up. The distinction between geometry and mensuration is held to be artificial; while it is true that no experiments can establish absolutely that the sum of three angles of a triangle is equal to two right angles, practical methods, using the most accurate instruments that can be made, show that the three angles of a triangle are as nearly equal to two right angles as human beings ever require. This is sufficient for the present state of development. The work contains fourteen chapters and three appendices as follows: Geometrical Fundamentals—Measurement of Length; Measurement and Properties of Angles; Rectangles and Parallels—Measurement of Area; The Construction of Properties of Triangles; The Areas of Parallelograms and Triangles; Construction and Mensuration of Polygons; Mensuration of the Circle and Ellipse; Some Geometrical Properties of the Circle; Mensuration of Prisms and Cylinders — Measurement of Volume; The Theorem of Pythagoras and Its Applications; Proportion—Drawing to Scale; Mensuration of Pyramids and Other Solids; Mensuration of Irregular Figures; The Trigonometrical Solution of Triangles; Duodecimals; Trigonometrical Tables; Answers to the Numerical Exercises. The numerical exercises interspersed throughout the work offer the student many examples to be worked out. The book lends itself to home study as well as regular school work. The typographical make-up is excellent.

NEW CATALOGUES AND CIRCULARS

A. W. Cadman Mfg. Co., Pittsburg, Pa. Catalogue and price list No. 5 of valves and other specialties.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 150 on Chicago pneumatic coal drills.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Bulletin on the automatic motor control as applied to LeBlond motor-driven lathes.

Volcano Torch & Mfg. Co., Erie, Pa. Circular of the "Volcano" gasoline blow-torch which generates the pressure required to operate it.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Price list of portable ozonators for house and general use.

Lagonda Mfg. Co., Springfield, Ohio. Catalogue of Lagonda automatic cut-off valves, showing installations in manufacturing plants, power stations, hospitals, railroad stations, etc.

National Tube Co., Frick Bldg., Pittsburg, Pa. Booklet of the N. T. C. regrinding globe valves, containing a catechism designed to show the advantages of this make of valve.

Perfection Spring Co., Cleveland, Ohio. Short treatise on physics and chemistry with reference to the care of automobiles and the manufacture of springs as conducted by the company.

Stow Mfg. Co., Binghamton, N. Y. Bulletins of Stow ½-inch electric breast drill, electric bench grinder, electric toolpost grinder and "Gee Whiz" radial flexible boring machine for wood-working.

Dyer Smith, 32 Liberty St., New York City. Reprint of an address entitled, "Patents—Some Essential Facts for the Engineer," presented before the students of Lehigh University, January 9, 1914.

Grant Engineering Co., Free Press Bldg., Detroit, Mich. Booklet on "Pioneers," being an appreciation of John James Grant by Elbert Hubbard. The many friends of Mr. Grant will read this short account of his life and works with interest.

Oster Mfg. Co., 2107 E. 61st St., Cleveland, Ohio. Circular of the new Oster cutting-off and reaming machine for pipes and tubes, having a maximum capacity for ¼-inch to 2-inch pipe inclusive, and a minimum capacity for ¼-inch pipe.

Ronald Trist & Co., Ltd., 4 Lloyds Ave., London, England. Circular of the thermo-feed differential governor for steam boilers. The apparatus will keep the water level at the same height within one-eighth inch, its operation being entirely automatic.

Argentine Social Museum, Buenos Aires, Argentine. Pamphlet giving part of the statutes of the Argentine Social Museum, treating of the object, methods of action, lectures, library, monthly bulletin, members and adherents, international relations, permanent exposition, etc.

Sprague Electric Works of the General Electric Co., 527-531 W. 34th St., New York City. Catalogue No. 329 of electric fans for 1914, comprising both direct current and alternating current desk and bracket fans, oscillating fans, residence fans, ceiling fans and exhaust fans.

Jackson Machine Tool Co., Jackson, Mich. Circular of the No. 6 duplex die sinker, designed for cutting drop-forge dies or metal core boxes. It has a longitudinal feed of 40 inches, cross feed of 13 inches and vertical feed of 21½ inches. The net weight of the machine is 4700 pounds.

Wheelock Mfg. Co., Wheelock, Vt. Circular of flexible metallic tubing made wholly of steel wire with no packing. This tubing is recommended for use on automatic screw machines, gear-cutters, milling machines, and other machines using oil or other lubricant on the cutting tool.

Windsor Machine Co., Windsor Vt. Catalogue of the Gridley automatic multiple spindle drill designed for rapidly drilling parts which are difficult to handle in the ordinary manner. Details of the machine are shown and examples of drilled work for which it is especially suited.

Hammacher, Schlemmer & Co., 4th Ave and 13th St., New York City. Catalogue of casters for machine shops and factories and all purposes, containing thirty-eight 9 by 12 inch pages and 190 illustrations. The catalogue shows twenty-four distinct lines of casters, including a full line of truck casters.

General Electric Co., Schenectady, N. Y. Bulletins A 4200, 44590, 45600, 45601 and 47400 on strain insulators and strain clamps, type ML governor for motor-driven air compressors, vacuum tube lightning arresters, artificial lightning arresters for alternating current circuits and Type F form K 12 oil switches, respectively.

Coates Clipper Mfg. Co., Worcester, Mass. Bulletin 24 on Coates "Flexishaft," showing applications of this type of flexible transmission shaft to drilling, polishing, grinding, erasing, setting screws, etc. The bulletin is profusely illustrated and shows many interesting applications of Coates tools and devices in manufacturing, repair and jobbing work.

Allen-Bradley Co., 495-497 Clinton St., Milwaukee, Wis. Bulletin B-541 on Type H resistance starting switch for alternating current induction motors which is claimed to give the motor absolute protection from running single phase should only one fuse blow or if for any other reason one line becomes interrupted, and to give positive no-voltage protection in all phases.

Detroit Tool Co., Detroit, Mich. Catalogue of a semi-automatic four-spindle drilling machine, in which the drill spindles are cam-operated, thus insuring positive feed. The claims made for the machine are: saving of time, drills, floor space and belt troubles. The catalogue shows a number of examples of automobile work advantageously drilled on this type of machine.

Mummert-Dixon Co., Hanover, Pa. Catalogue of oilstone grinders for fine edge tools. Several sizes and types of machines for grinding the knives of wood-working machines are shown and an oilstone

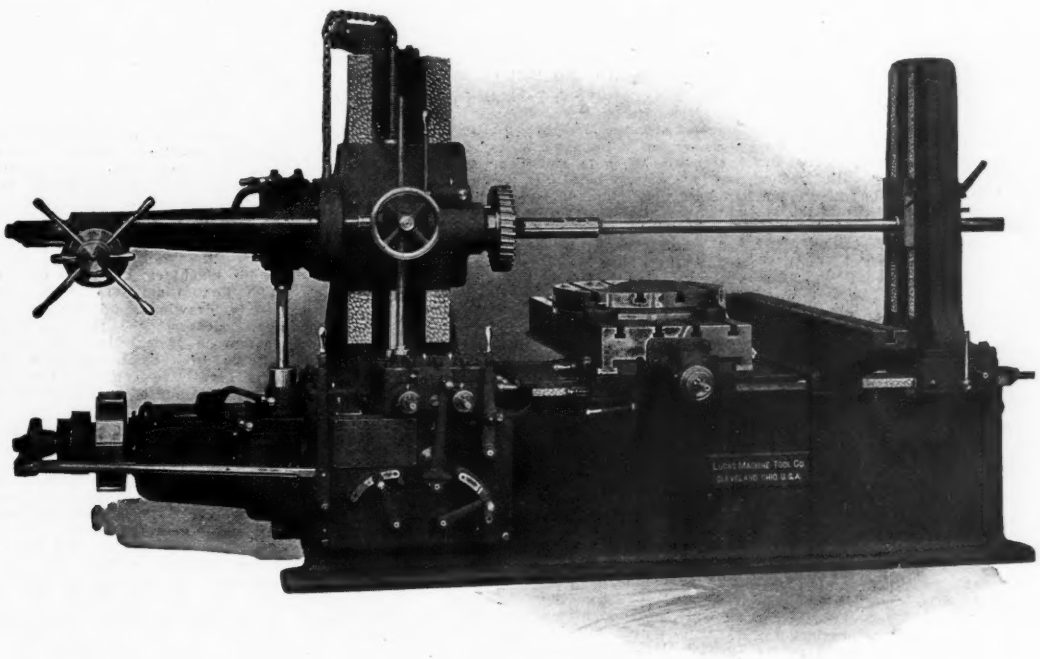
YOU DON'T VERY OFTEN SEE A

LUCAS

"PRECISION"

Boring, Drilling and Milling Machine

in a second-hand list, do you? And when you do, it doesn't STAY in the list very long, does it—in spite of the fact that we've sold nearly 800 new ones, too. When a second-hand "PRECISION" IS sold, it always



BRINGS A GOOD PRICE. In other words, a "PRECISION" user seldom wants to sell it, but if he does, HE CAN SELL IT

P. D. Q.

or in the words of one of our customers, "The 'PRECISION' is ALWAYS AN ASSET."

Lucas Machine Tool Co., NOW AND ALWAYS OF Cleveland, O., U.S.A.

AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada. H. W. Petrie, Ltd., Toronto, Ont.

face and tool grinder for machine shops. This is a two-purpose machine, designed for sharpening scrapers, lathe tools, planer tools, etc., and for face grinding and all kinds of vise work.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Circular of the Blanchard high-power vertical surface grinder, listing work being done on Blanchard grinders in customers' shops. The numbered paragraphs describe the work and give production figures, limits, etc. The circular will be found of suggestive value to manufacturers having work that can be finished on this type of machine tools.

Standard Gage Steel Co., Beaver Falls, Pa. Catalogue and price-list of turned and cold-drawn steel shafting; cold-drawn screw stock; finished flats, squares, rounds, hexagons, angles, channels and special shapes; compressed steel elevator guides; connecting-rods; crankshafts; finished machine keys; Woodruff keys; taper pins; machine racks; feed-screws; lead-screws and worms; automatic machine work and drop-forgings.

Richardson-Phenix Co., Milwaukee, Wis. Bulletin 57 of the Phenix sight-flow indicator, illustrating and describing a device which can be inserted in any pipe line carrying a liquid, such as the water lines of jacket-cooled transformers and the supply pipes of gas engines and air compressors. The device shows at a glance or indicates electrically by lighting a lamp or ringing a bell when the flow of liquid is interrupted.

Hess-Bright Mfg. Co., Front St. and Erie Ave. Philadelphia, Pa. Data sheets showing mountings of Hess-Bright ball bearings for vertical armature shaft of electric motors, release fork for automobile clutch, front and rear truck hubs, marine propeller shafts, shafts without shoulders to support radial loads and opposed thrusts, double exhaust fan and wheel hubs. Tables of dimensions of annular radial bearings and thrust bearings are included.

Acme Machine Tool Co., Cincinnati, Ohio. Bulletins of the "Acme" combination flat turret lathes, single pulley drive, 3¼ by 36 inches capacity and 2¼ by 26 inches capacity; Cincinnati "Acme" screw machine from ⅝ by 4 inches capacity to 2¼ by 11 inches capacity in seven sizes; Cincinnati "Acme" turret lathes in 14-, 16- and 18-inch and 20-inch sizes. The bulletins illustrate details of construction of headstocks, roller feeds, turret toolholders, etc.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin 15 containing a set of specifications for pipe used for drilling purposes; an illustration showing samples of "National" pipe after torsional tests have been made ranging from 180,000 to 215,000 inch-pounds; also illustrations and tables showing weights and dimensions of "National" drill pipe, "National" special rotary pipe, "National" special upset rotary pipe and "National" seamless interior upset drill pipe.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Catalogue 40, containing 128 pages 8⅜ inches by 11 inches. The first fifteen pages show the home office, factory and branch office facilities. In the following pages hydraulic presses and pumps for all high pressure purposes are illustrated and described. Various designs of hydraulic presses and pumps recently described and illustrated in MACHINERY are shown which convey an idea of the scope of the field covered by the company.

Niles-Bement-Pond Co., 111 Broadway, New York City. Circular of Niles new design boring and turning mills of 44 inches, 53 inches, 62 inches and 73 inches table capacity. These machines are furnished with direct-current motor drive, push-button control and automatic brake for table, with alternating-current motor drive or belt drive through a single pulley. Independent motors located on the top brace of the mill are provided for adjusting the cross-rail and providing rapid power traverse to the bars and saddles.

Garvin Machine Co., Spring and Varick Sts., New York City. New 1914 catalogue containing 322 pages, 4 by 6¼ inches. This catalogue illustrates and describes the complete line manufactured by this company and contains a number of tables of value to mechanics, draftsmen, etc. Among the machines described are milling machines, profilers, cam cutters, die slotters, screw slotters, tapping machines, duplex horizontal drills, screw machines, monitor lathes, grinders, and various classes of special machinery.

Lees-Bradner Co., Cleveland, Ohio. Catalogue of Lees-Bradner thread milling machines made in four sizes, all having the same diameter capacity but varying in length. The machines are primarily designed for milling screws such as worms, lead-screws, feed-screws, rear axle worm drives and steering worms for automobiles, etc. Spiral gears and spur gears can also be cut on the machines. The catalogue is a handsome publication 8½ by 11 inches, illustrated with fine halftones. Three diagrams are shown to designate the various parts by name.

Bill Deezy Co., 141 Milk St., Boston, Mass. Catalogue of construction material for toy making, model making, etc. The principal parts are a four-arm flexible joint and coppered steel rods. With these parts a great variety of forms can be constructed by modifying the flexible joint. This is trimmed, bent or twisted as required. Inventors, model-makers, engineers and others can sometimes, no doubt, utilize these construction materials, especially as wheels are also furnished which enable the constructor to make working models.

Garvin Machine Co., Spring and Varick Sts., New York City. Circular No. 205, being a pocket daily reminder of the Garvin products. It illustrates the line of Garvin milling machines, including knee-type, vertical spindle type and Lincoln type milling machines, cam or form milling machines, duplex milling machines, profile milling machines, die slotting machines, screw slotting machines, etc. Grinding machines, hole grinding machines, right-angle drilling machines, automatic tapping machines, and automatic oil grooving machines are also shown.

Keystone-Hindley Gear Co., 704 Pennsylvania Bldg., Philadelphia, Pa. Catalogue of Keystone-Hindley worm-gears. The lists are accompanied with diagrams and the gears and worms are numbered so that customers can order any combination desired within the range of the lists by giving the number and the hand of the helix. For example, gear No. 2013 is 16 to 1 ratio; 10.18 pitch diameter of wheel; 1 circular pitch; 32 teeth. The pitch diameter of the worm is 4.57 inches; lead, 2 inches; number of threads, 2; distance from center to center, 6.625 inches; either right or left hand.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins 1037 and 1038, superseding Bulletins 1035 and 1036 on Type B limit stops for direct-current motors and Form H dynamic braking Dinkey controllers for direct-current motors, respectively; also reprints of article, "Application of Electric Power in the Foundry," illustrating and describing the application and use of electric controllers on cranes, sand mills, sprue cutters, tumbling barrels, cupola blowers, pipe core machines, roller-ramming molding machines and grinders. The use of lifting magnets in foundries for handling castings is illustrated with a number of striking views.

Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Data book 125 on "Silent Chain" drives, which will be welcomed by the mechanical public. For the first time a book has been published by a manufacturing concern which will enable users of power to select the correct silent chain drives for their work and to determine the exact costs from list prices shown in the book. Besides giving engineering information in simple and compact form, this data book describes many uses of silent chain for the efficient transmission of power and shows illustrations of a large variety of applications. It contains 112 pages bound in flexible red covers. Copies can be obtained free of charge by addressing the Link-Belt Co.

New York Belting & Packing Co., 91-93 Chambers St., New York City. General catalogue of mechanical rubber goods. Rubber belting for all purposes is listed and rules for calculating the horsepower of belts and directions for the use and care of rubber belts are included. Rubber hose, armored hose, steam and air hose, suction hose, etc., are listed, the various types being illustrated. Packings in great variety, diaphragms, hot water valves, washers, perforated mats, rubber tubing, hat bags, rubber stoppers, hammer cushions, rubber tiling, are a few of the specialties also included. The catalogue is a fine example of typographical excellence, illustrations, printing and paper being high grade. The illustrations of rubber tiling are beautifully printed in colors.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin 11-B on the history, characteristics and advantages of "National" pipe, containing eighteen chapters, as follows: 1. A Short History of Pipe and Early Methods of Manufacturing. 2. First American Pipe Furnaces. 3. History of National Tube Company. 4. Materials for Pipe. 5. The First Steel Pipe. 6. Pipe Threading. 7. Spelerizing "National" Pipe. 8. Full Standard Weight Pipe only Manufactured. 9. The Continuous Uniformity of "National" Pipe. 10. Physical Properties. 11. Bursting Pressure. 12. The Inspections and Tests of "National" Pipe. 13. Changes in the Tubular Industry (1888 to 1913). 14. "National" Pipe for Refrigeration Systems. 15. Corrosion of Pipe in Hot Water Systems. 16. The Design of Hot Water Supply Systems to Minimize Corrosion. 17. Corrosion of Pipe in Coal Mines. 18. Remarkable Ductility of "National" Pipe.

TRADE NOTES

Keuffel & Esser Co., Hoboken, N. J., announces that the price of Smith's fountain drawing pens which were described in the July, 1913, number of MACHINERY has been reduced from $7 to $5.

Monarch Machine Co., Sidney, Ohio, manufacturer of engine lathes, is putting up an office building; also an addition to its plant 90 by 150 feet. The company reports a rapidly increasing business.

Interstate Machinery Co., Troy, N. Y., recently erected a large addition to its plant. The company buys and sells used iron- and wood-working machinery and is also a jobber in new machinery.

C & C Electric & Mfg. Co., Garwood, N. J., announces that the Indianapolis territory will be temporarily taken care of by its Cincinnati representative, F. A. Saylor, 6th and Vine Sts., Cincinnati, Ohio.

National Tube Co., Frick Bldg., Pittsburg, Pa., because of certain articles published in the technical press in regard to wrought-iron pipe, makes the statement that it has not made wrought-iron pipe for some years.

Carpenter Steel Co., Reading, Pa., has appointed James W. Sederquist district sales agent for Boston and Eastern New England with offices at 131 State St., Boston, Mass. Mr. Sederquist will be assisted by William T. Dunn.

Hill Clutch Co., Cleveland, Ohio, manufacturer of power transmission machinery, announces the appointment of P. W. Alling as Eastern representative in charge of the company's New York office at the Hudson Terminal, 50 Church St., New York City.

Index Office, Inc., 31 W. Lake St., Chicago, Ill., has been incorporated for indexing, compiling and abstracting literary and statistical material for the use of manufacturers, scientists and investigators. Aksel G. S. Josephson, secretary. The annual membership fee is $5.

D. H. Stoll Co., Inc., Buffalo, N. Y., manufacturer of presses, shears, dies and other sheet-metal working machinery, has recently arranged for the construction of a three-story addition to its plant. The building will be 40 feet wide by 118 feet long and will be constructed of brick and steel.

Allen-Bradley Co., 495-497 Clinton St., Milwaukee, Wis., announces that its Chicago representative, Frank L. Gohl, has moved from his old headquarters at 540 Commercial National Bank Bldg. to 307 Webster Bldg., 327 La Salle St., Chicago, Ill. The change was necessitated by an increase in business, the old offices proving too small to accommodate the same.

Carter & Hakes Co., Sterling Place, Winsted, Conn., manufacturer of Lincoln milling machines and special machinery, has made Robert W. Barwood of Philadelphia, Pa., a well and favorably known machine tool salesman, its representative in New England and the territory adjacent to New York and Philadelphia. Mr. Barwood's headquarters will be at the Bourse, Philadelphia.

Lapointe Machine Tool Co., Hudson, Mass. Walter F. Rice, Joseph F. Owens, and their associates have taken over the common stock formerly owned by J. Keyes Hall and Joseph N. Lapointe. The officers of the company are Walter F. Rice, president; Joseph F. Owens, treasurer; and William P. Everts, secretary. The new management will put on additional men at once in order to make better deliveries.

Acklin Stamping Co., Toledo, Ohio, reports an unusually bright outlook for business during the coming year. A few days ago the company entered its order No. 1000. When it is remembered that the company began business about two and one-half years ago and that many orders for stampings are from 500,000 to 2,000,000 pieces, it can be readily seen how much business is represented by one thousand orders.

Tate-Jones & Co., Inc., Empire Bldg., Pittsburg, Pa., installed the new heat-treating department of the Ingersoll-Rand Co.'s plant at Phillipsburg, N. J. The plant handles a large output of drills and compressors and the furnace equipment consists of two large double chamber annealing furnaces, two semi-muffle furnaces for pre-heating, six lead and two solution baths for hardening and three oil baths for tempering. All the furnaces are fired with fuel oil.

Dodge Mfg. Co., Mishawaka, Ind., has purchased the gear patterns, gear machinery and powder machinery patterns of the I. & E. Greenwald Co., Cincinnati, Ohio, together with all records, drawings and the good will of the business. Most of the patterns and all the records are now in Mishawaka. The addition of the gear patterns to the already extensive list of Dodge gears gives the company the most complete line and widest list of gears in the United States.

H. W. Johns-Manville Co. has removed its Indianapolis, Ind., and Louisville, Ky., branches to larger quarters with better facilities for handling increased business. The new address of the Indianapolis branch is 408-410 N. Capitol Ave., and that of the Louisville branch, 659-661 So. Fourth Ave. Both branches will include ample warehouse accommodations in addition to showrooms for the display and sale of the company's line of asbestos roofing, pipe coverings, insulating materials, lighting fixtures, automobile accessories, etc.

L. S. Starrett Co., Athol, Mass., has accepted the invitation of the Rice Leaders of the World Association to join its organization. This association will be limited to fifty manufacturers from all lines, and the invitation is extended only to the recognized leaders in the various kinds of manufacturing. Competitors in any line cannot be members. The association which was founded by Elwood E. Rice, president, has for its principles honor, quality, strength and service, and an emblem which signifies these principles will be worn by salesmen and other representatives of the members of the association.

Ingersoll-Rand Co., 11 Broadway, New York City, has placed George A. Gallinger, of Pittsburg, in charge of its pneumatic tool department with the title of manager of pneumatic tool sales, headquarters at 11 Broadway. The company felt warranted in establishing this special department and in placing at the head of it a man who understands the business from a mechanical as well as a commercial standpoint. Mr. Gallinger's time and service are at the disposal of those contemplating the use of pneumatic tools and his long experience and practical knowledge commend him to the consideration of the trade in general.

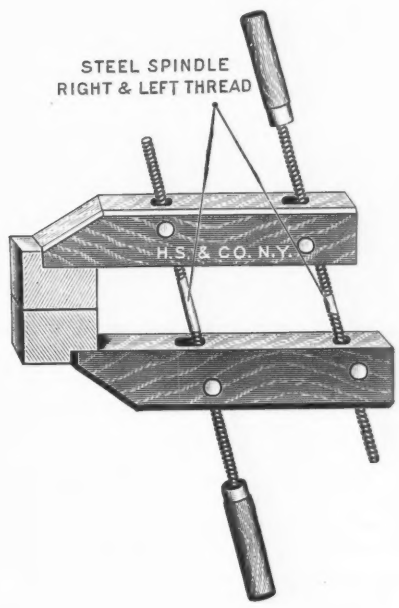
H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, states that the new South Works of the J. I. Case Threshing Machine Works at Racine, Wis., is roofed with asbestos and Trinidad Lake asphalt, two of the most enduring mineral substances known. Asbestos is an indestructible fibrous rock, and for roofing purposes it is made into a felt, layers of which are cemented together wth asphalt. This roofing is not affected by changes of temperature. The hottest weather does not cause it to dry out, melt or run, and the coldest weather does not crack it. A booklet describing the roofing in detail will be sent to anyone interested.

Cleveland Twist Drill Co., Cleveland, Ohio, has begun the publication of a monthly house organ called "Drill Chips" edited by Andrew E. Coburn.

YOUR PATTERN SHOP

SHOULD HAVE SAMPLES OF THE

JORGENSEN ADJUSTABLE HAND SCREWS



BECAUSE

they do more work than any hand screw heretofore made. Steel spindles in movable steel sockets permit varying angles of the jaws, thus multiplying their usefulness and obviating the carrying of many other makes and kinds of clamps.

For parallel work, the only kind possible with the old-style screw, Jorgensen screws are incomparable.

Note the added advantage of the hundreds of possible angles, invaluable in many trying cases.

WE WILL SEND A SAMPLE

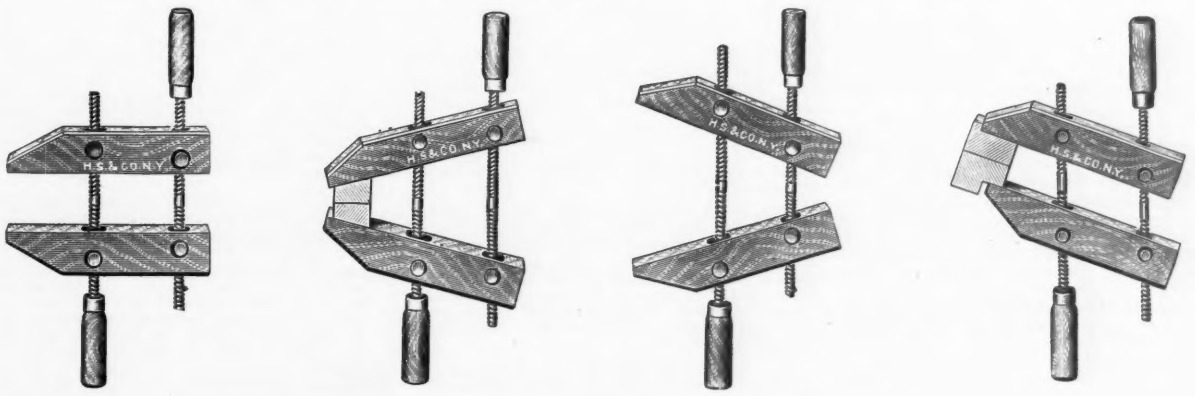
to any reputable concern having a wood-working or pattern-making department. Ask for Special Circular No. 3179.

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

4th Avenue and 13th Street **New York, Since 1848**

Showing some of the possibilities of the Jorgensen Hand Screw.



which will be sent free to anyone interested in drills, reamers, cutters and similar tools. The make-up of this house organ is out of the ordinary. It consists of a cover and sixteen pages of miscellaneous humor, advertisements of Cleveland products, etc. The first inside leaf is five inches long and the following leaves increase progressively to a length of nine inches. At the bottom of the first page of each leaf is an illustration of a Cleveland product. The result is that all eight products can be seen at a glance when the front cover is open.

Foxboro Co., recently organized under the laws of Massachusetts, has taken over all assets and liabilities of the Industrial Instrument Co. of Connecticut which was a holding company, and of the Standard Gage Mfg. Co. of Connecticut, with factory at Foxboro, Mass. The Foxboro Co. manufactures the rapidly growing line of Foxboro improved recording gages, thermometers, tachometers and pyrometers which are sold by the Industrial Instrument Co. having main office at Foxboro with branch offices in New York City, Chicago, Ill., St. Louis, Mo., San Francisco, Cal., and Birmingham, Ala. The Foxboro Co. owns all of the capital stock of the Industrial Instrument Co. Edgar H. Bristol and Bennet B. Bristol continue as president and treasurer, respectively, of the Foxboro Co. In fact, there are no changes in the personnel or policies of the companies, the above changes being made to concentrate and simplify the organization.

New Process Gear Corporation, Syracuse, N. Y., is erecting a three-story 40 by 100 foot concrete and steel building to provide additional machinery facilities for spur and bevel gear work. The new building is to be absolutely fireproof with brick curtain walls and concrete floors, and will contain entirely new equipment. Among the machines already ordered are seventeen Gleason bevel gear generators, fourteen Potter & Johnston automatic turret lathes, six Gould & Eberhardt bevel gear blocking or roughing out machines and two Fellows spiral gear shapers. These will serve as additions to the larger batteries of similar machines now in use in the main plant. The New Process Gear Corporation was first incorporated as the New Process Raw Hide Co. in 1888, the earlier name being used because the company was then extensively engaged in the manufacture of "New Process" noiseless raw-hide gears and pinions, a line which has in later years been supplemented by metal gear work to an extent that necessitated the change to the present name January 1, 1913.

Miscellaneous Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents

TEST INDICATORS.—H. A. LOWE, 1374 East Eighty-eighth St., Cleveland, Ohio.

HARDENING, Carbonizing, Galvanizing. C. U. SCOTT, Head of Wall St., Davenport, Iowa.

BOOKS ABOUT ELEVATORS.—Best published. W. A. MORSE, 19-21 Union Place, Yonkers, N. Y.

LIVE SHOP AGENTS WANTED to distribute our tools. WELLES CALIPER Co., Milwaukee, Wis.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

YOUR BLUEPRINTS MADE by electric machine; 1½ cents per square foot. Mail orders returned the same day received. Address J. M. YOUNG, 431 Union Bldg., Anderson, Ind.

DISC CALCULATING CHARTS for draftsmen and designers. CARPENTER DRAFTING CO., 49 Oakland Terrace, Hartford, Conn.

PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

AGENCY WANTED in New York City and vicinity, small meritorious article; automobile accessory preferred. ROOM 710, Park Row Building, New York.

WANTED.—EXPERT OPERATORS on Gleason generators, National-Acme and Potter & Johnston turret lathes. NEW PROCESS GEAR CORPORATION, Syracuse, N. Y.

ELEVATOR SALESMAN WANTED to travel in New York State. State age, experience and salary expected. Address Box 630, care MACHINERY, 140 Lafayette St., New York.

AUTOMATIC AND SPECIAL MACHINES designed. Working drawings. Tracings. Special Tools and Fixtures designed. C. W. PITMAN, 3519 Frankford Ave., Philadelphia, Pa.

GENERAL MACHINERY DESIGNED, working drawings; tracings; patent office drawings; general drafting. Accuracy, prompt attention. SAMUEL GOODMAN, 13 Park Row, New York.

WANTED.—POSITION AS DRAFTSMAN by I. C. S. student. A-1 all-round mechanic. "Simple way is the best way." Cleveland, O., preferred. Address Box 628, care MACHINERY, 140 Lafayette St., New York.

WANTED.—MODERN PLAIN RADIAL DRILL with three or four foot arm. Must be in first class condition. State price. SARANAC MACHINE CO., Benton Harbor, Mich.

POSITION WANTED.—OFFICE MAN; first-class bookkeeper; cost accountant; valuable man for machinery or jobbing shop; 19 years' experience; references A-1. Address Box 632, care MACHINERY, 140 Lafayette St., New York.

HANDBOOK for Machinists and Toolmakers (vest pocket size), condensed information most needed in the shop; also general information for shop men. 120 pages; 25 cents. WM. CUTHBERTSON, 39 Springside Ave., Pittsfield, Mass.

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